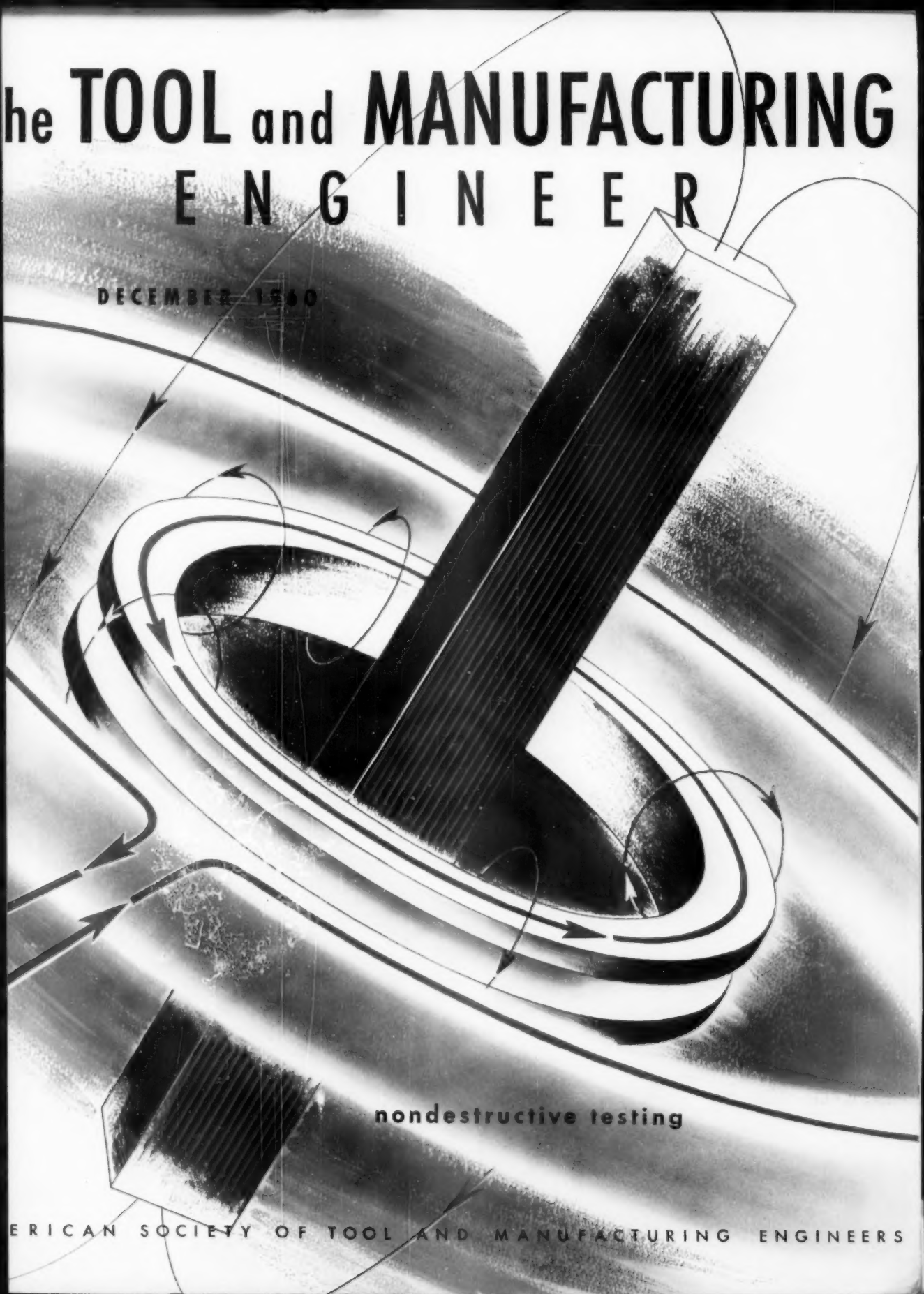
he TOOL and MANUFACTURING ENGINEER

DECEMBER 1960



nondestructive testing

ERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS

As these scale models show, Heald's new line of standard "building-block" units can be combined in virtually any desired arrangement for single or multiple station automated production equipment. Slide units and Borizers can approach the work vertically, horizontally or at an angle, to perform any desired drilling, boring, reaming, tapping, probing, facing or grooving operations within their range and capacity.

The flexibility of these standard units provides maximum versatility in meeting your specific automation requirements—simplifies even major job changeovers by facilitating retooling, removal, relocation or addition of work stations—and safeguards your investment by substantially reducing losses from obsolescence.

Your Heald engineer will be glad to show you how this "building-block" approach can solve your automation problems from rough to finish.

It PAYS to come to Heald

THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.
Worcester 6, Massachusetts

Chicago • Cleveland • Dayton • Detroit • Indianapolis • Lansing • Milwaukee • New York • Philadelphia • Syracuse

HEALD

Use Reader Service Card, CIRCLE 102

the TOOL and MANUFACTURING ENGINEER

Volume 45
No. 6

December
1960

Mesons, Magnets and Manufacturing ..... *By T. W. Black* 37
By successfully fabricating the giant magnets of a new proton accelerator, manufacturing engineers are contributing to nuclear research.

Gadgets 45
Die rolls grooves . . . plate holds center gages . . . index fixture mounts different parts . . . cam die pierces multiple holes.

How To Cut Tool and Die Costs—Part 3 ..... *By J. S. Pendleton Jr.* 49
Heat-treat failures can be minimized by well-planned fixturing in the furnace, correct atmospheres and controlled quenching.

Contours Without Computers ..... *By Robert Heslen* 52
A new numerical control system for contour machining can be programmed manually, without tedious computation or a digital computer.

Chemical Milling of Honeycomb Core Blanket ..... *By Raymond G. McCue* 60
An ingenious tooling method makes it possible to chemically mill honeycomb core to fit contoured facing sheets.

Method Control in Testing—Key to Reliability ..... *By A. E. Christensen* 61
Nondestructive testing by magnetic particle methods illustrates some ways in which any inspection operation can be made more reliable.

Drilling Holes to Size in One Operation ..... *By Frank Zagar* 65
Step drills maintain exact hole sizes, provide excellent finishes and in many cases eliminate the need for reaming.

How To Use Positional Tolerances—Part 1 ..... *By Edward S. Roth* 67
Positional tolerances lead to better communications between product designers, manufacturing engineers and quality control personnel.

Improving the Reliability of Ground Parts ..... *By James E. Price* 75
Residual stresses left by grinding can cause premature failure of parts in service. These stresses can be avoided.

Belt Grinding Assures Precision Gage of Strip 79
Stainless steel strip is being produced to the exacting tolerances required for Space-Age applications with the aid of abrasive belts.

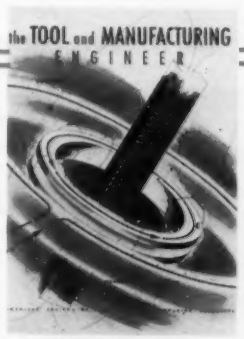
Designing Harmonic Cams (Reference Sheet) ..... *By Louis H. Harris* 81
Both methods of designing precision cams—layout and calculation—can be simplified, following a logical approach.

ASTME IN ACTION—SEMINARS BRING EXPERTS CLOSE TO HOME 85

ANNUAL EDITORIAL INDEX, 1960 205

President's Editorial 35
Designed for Production 56
Engineering Bookshelf 146
Field Notes 143
Letter from the Editor 3
Looking Ahead (newsletter) 220
Men at Work 139
Progress in Production 105
Tech Digests 155
Technical Shorts 151
Tool Engineering in Europe 153
Tools at Work 70
Tools of Today (new products) 109
Trade Literature 149
Who's Meeting and Where 137

THIS MONTH'S COVER



Fine cracks and internal imperfections in a part can be quickly made visible by magnetic particle inspection, in which metallic particles are dusted over a magnetized part. Here a bearing race is being checked for cracks. The flow of electric current and the shape of the magnetic fields are shown by arrows. An article starting on page 61 discusses this important method of nondestructive testing in detail.

THE TOOL AND MANUFACTURING ENGINEER is regularly indexed in the *Engineering Index Service* and *Applied Science & Technology Index*, used generally in libraries. The magazine is available in microfilm form at moderate cost.

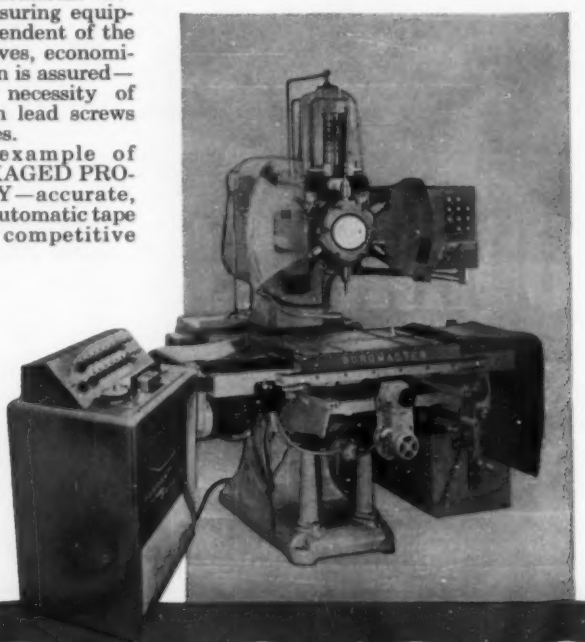
POSITIONING BREAKTHROUGH!

BENDIX ANNOUNCES Numerical Control System for point-to-point work

Long a leader in the numerical contouring field, Bendix has acquired exclusive U. S. sales and service rights on the Ferranti FP-22 numerical POSITIONING control system for machine tools.

The FP-22 is truly the practical answer to the positioning requirements of jig borers, drilling machines, punch presses and other point-to-point applications. Because its measuring equipment is independent of the machine's drives, economical installation is assured—without the necessity of ultra-precision lead screws and gear boxes.

Another example of Bendix PACKAGED PRODUCTIVITY—accurate, dependable, automatic tape control for competitive efficiency.



Position display numbers shown here are actual size.

Outstanding features of the Ferranti FP-22 include:

Floating zero—quick and easy set-up—low cost tooling.
Dial input—provides manual operation flexibility.
Continuous position display—available as an option.
"Accumulator" power supply—eliminates line voltage fluctuations.
Fully transistorized—requires less warm-up time—less power—less maintenance.
No contacting parts in measuring units—no wear—no eventual loss of accuracy.

Backed by complete service and customer training programs.
For additional information, contact your machine tool distributor or Bendix.

Industrial Controls Section
21820 Wyoming, Detroit 37, Michigan

THE Bendix CORPORATION

Use Reader Service Card, CIRCLE 2

Harry E. Conrad
Executive Secretary

Editorial Staff

John W. Greve
Editor
Theodore W. Black
Senior Associate Editor
M. L. Stone
News Editor
Robert Heslen
Associate Editor
Daniel B. Dallas
Associate Editor
Patricia Libel
Assistant News Editor
Rosalie Corson
Assistant Editor
Michael Babala
Art Editor
Henry Werner
Assistant Art Editor
Joan Crampton
Editorial Assistant

Business Staff

Michael Jakesy
Business Manager
Austin G. Cragg
Director of Sales
Peter A. Toma
Production Manager

Regional Advertising Managers

Francis Baldwin
New York
Donald N. McElwain
West Hartford
John G. Clarke
New Bedford, Mass.
George J. Zavis
Cleveland
Alan Cobleigh
Detroit
Stanley F. Girard
Chicago
Gus Krimsier
Atlanta
Dillenbeck-Galavan, Inc.
Los Angeles

Editorial & Business Offices
10700 Puritan Ave.
Detroit, 38, Mich.
UNiversity 4-7300

Regional Advertising Offices
Address and telephone numbers are listed in "Index" of Advertisers in this issue.

Publication Office
239 E. Chicago St.
Milwaukee, Wis.

THE TOOL AND MANUFACTURING ENGINEER is published monthly, except semimonthly in March, in the interest of members of the American Society of Tool and Manufacturing Engineers. Second class postage paid at Milwaukee, Wis. Yearly subscriptions: members, $2.00, nonmembers, $6.00; Canada, $6.50, other countries, $8.00. Copyright 1960, American Society of Tool and Manufacturing Engineers.

Quality Pays

A frequently heard and very familiar slogan sums up our major objectives: build a better product at a lower price for more customers. Of these the first is the cornerstone and most important, particularly sinces our markets are being flooded with goods from abroad. When one builds a better product and when its quality is useful to the customer—dependable operation, low maintenance, good performance—there is no doubt as to the market, even if the price is higher than that of competitors.

Recently, Mr. E. B. Cleborne, president of Wallingford Steel Co. said his company builds a quality product. They sell all they can make, at home and abroad. Foreign competition is no problem, it is only a challenge. The product to which Mr. Cleborne refers is stainless strip, rolled to precision tolerances with a flawless finish.

The company produces strip as close to gage as the customer is willing to pay the cost. In this connection it is interesting to note how the cost per ton varies geometrically as the strip is rolled thinner and as the tolerances become more exacting. Maintaining a 3 percent tolerance, strip rolled to 0.002 inch costs about $8000. To roll off a half thousandth increases the cost to almost $12,000, and to roll another half thousandth to make 0.001 inch-gage brings the cost to $38,000. The tolerance limits for each instance are 60, 45 and 30 millionths inch, respectively.

At half the gage and half the tolerance the price per ton, in this case, multiples almost five times. This cost represents, of course, increases in time, labor, and scrap as well as investment in precision equipment—rolling, annealing, gaging—together with the all-important experience and know-how obtained through research, development and practice.

There is no substitute for quality no matter what the product. There is no shortcut to achieving this quality. It is obtained through the use of accumulated data and knowledge. Our survival as a nation depends upon such achievements and is worthy of the best engineering talent and ingenuity that we can apply.

John W Greve

EDITOR

BUSINESS IS UP

Get your share and keep it there!

Threadwell

MAKES THE BEST PRODUCT BETTER

INDUSTRIAL DISTRIBUTORS

THE RIGHT HAND OF PRODUCTION

Threadwell's fine line of cutting tools and gages is one guarantee of uninterrupted production, the surest way to stay in a competitive position.

To get out front and stay there make sure you include your Threadwell Distributor in your production planning.

THREADWELL TAP & DIE CO.
GREENFIELD, MASSACHUSETTS

Stocking Warehouses: New York — Cleveland
Detroit — Los Angeles — Greenfield, Mass.

Use Reader Service Card, CIRCLE 4

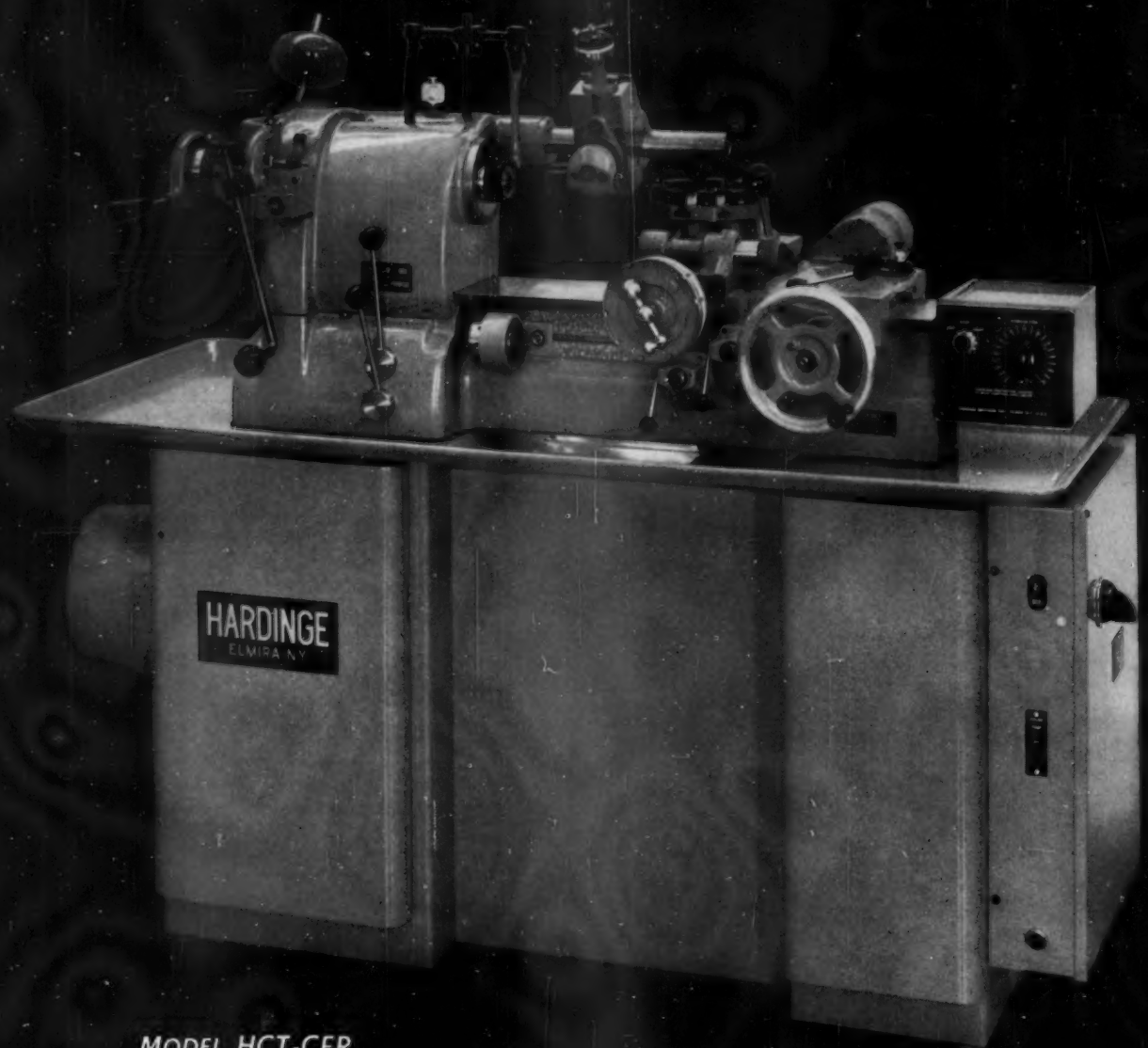
Use Reader Service Card, CIRCLE 5

THE NEW HARDINGE PRECISION CHUCKING MACHINE

HARDINGE
ELMIRA, N.Y.

With

- NEW PRODUCTION THREADING HEAD
- NEW ELECTRIC PRODUCTION DRIVE
- NEW POWER CROSS FEEDING TURRET
- NEW HARDINGE EASY READING BLACK AND WHITE DIALS

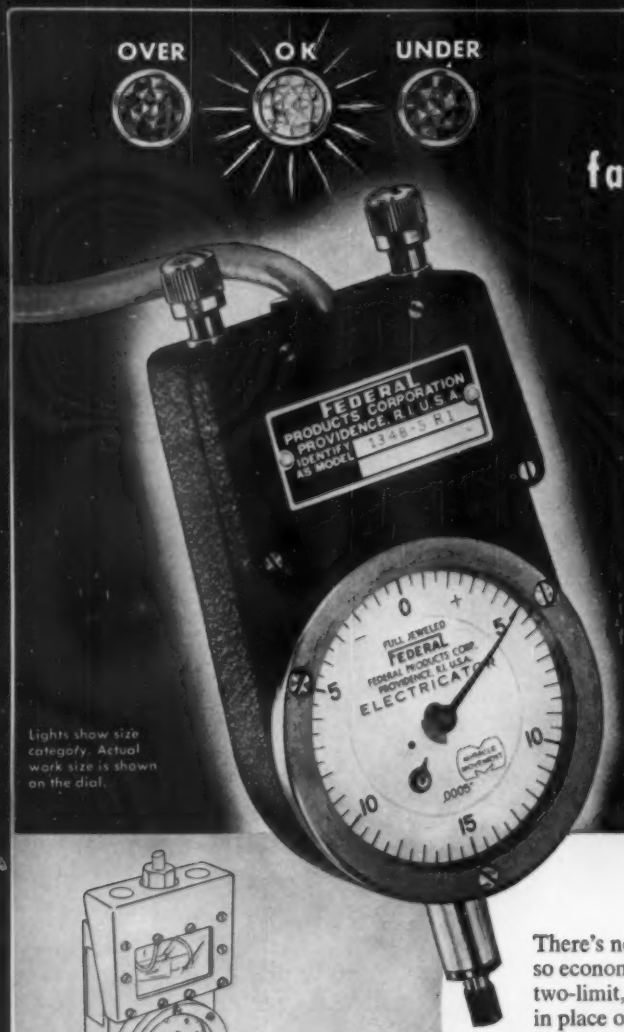


MODEL HCT-CFR

WRITE FOR FREE BULLETIN

HARDINGE BROTHERS, INC., ELMIRA, N. Y.

PERFORMANCE HAS ESTABLISHED LEADERSHIP FOR HARDINGE



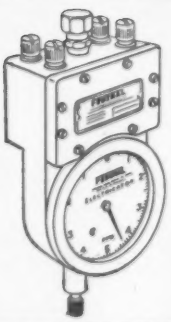
Lights show size category. Actual work size is shown on the dial.

faster gaging . . .

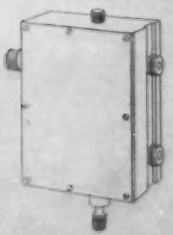
ELECTRIFYING RESULTS . . .

when you use the ELECTRICATOR

WETPROOF STYLE
(For each regular model)



DOUBLE UNIT MODELS
(Four limits, five categories)



ECCENTRICATOR
(For indicating eccentricity, runout, squareness)

There's nothing quite like the Federal Electricator — so easy to apply — so economical — so accurate . . . a Miracle Movement Dial Indicator and two-limit, spindle-actuated switch combined. Use it with tolerance lights in place of your dial indicator for faster, more accurate bench gaging. Use it together with a signal unit for fully automatic inspection or automatic machine or process control.

The Electricator is a high precision unit — switching accuracy is better than 50 millionths on all models. Voltage across the switch is extremely low and switching current is in the order of one milliampere. Therefore, arcing and pitting of contacts is eliminated and accuracy is reliably maintained. The Electricator is calibrated, so it requires only one master.

All Electricator models incorporate the new Federal Miracle Movement which is so wear-resistant . . . so shock resistant . . . you will probably never have to repair or replace it. Six regular models are immediately available from stock. Four different graduations — .0001", .00025", .0005", .001". Prices from $75.

The switching portion of the Electricator is available as a separate unit to operate tolerance lights and/or provide control limits without indicating actual size.

The Federal Eccentricator, a similar type of high precision unit, indicates eccentricity, runout, squareness, etc., *without* being influenced by normal piece-to-piece variations in size.

For more information, write . . .

FEDERAL PRODUCTS CORP.
61912 Eddy Street, Providence 1, R. I.

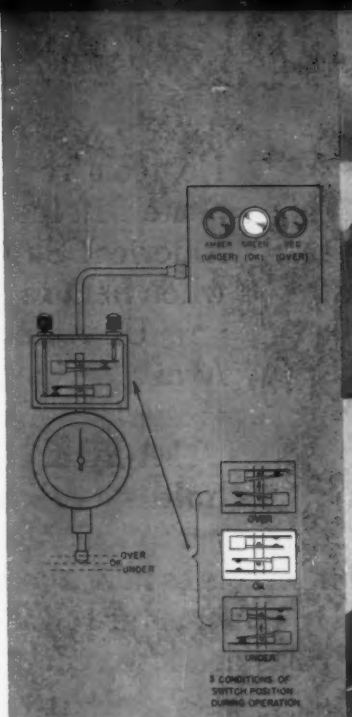
Ask **FEDERAL** *First*

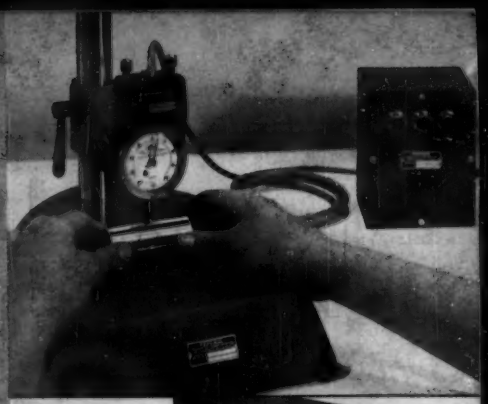
FOR RECOMMENDATIONS IN MODERN GAGES . . .
Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

FOR HIGH SPEED BENCH GAGING
(Single or Multiple Dimensions)

It's easy to install the Electricator in place of the dial indicator on your present comparator when you need greater speed. The Electricator eliminates having to make borderline decisions so you get more reliable results . . . and faster results . . . using less skilled help, and with less operator fatigue. Many concerns have up-graded their manual gaging this economical way with great success.

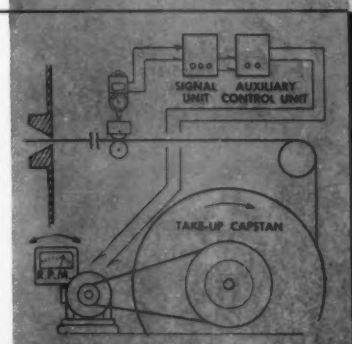
The Electricator offers the most economical way to make multi-dimension checks rapidly and reliably. The signal lights on its control panel instantly show the operator whether the piece is within tolerance or not. No need for operator to look at a group of indicators one by one in order to determine acceptability.

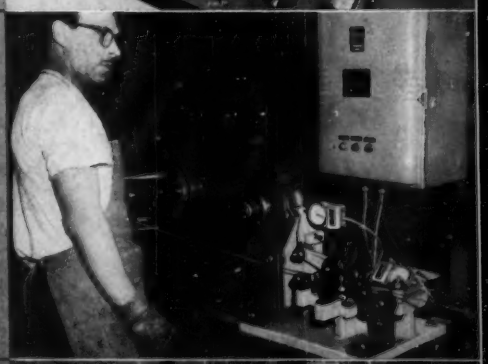




CONTINUOUS PROCESS CONTROL

Because the Electricator is compact, it can be installed easily on most continuous processes to indicate size trend accurately so correction can be made *before* scrap is produced. In many cases, Electricator, working into appropriate signal unit, can be used to *control* size so process automatically produces within tolerance.

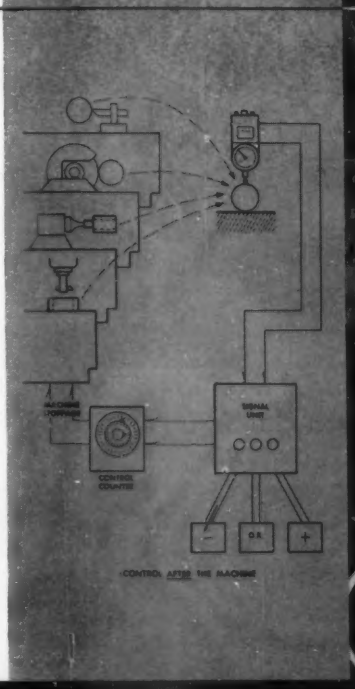


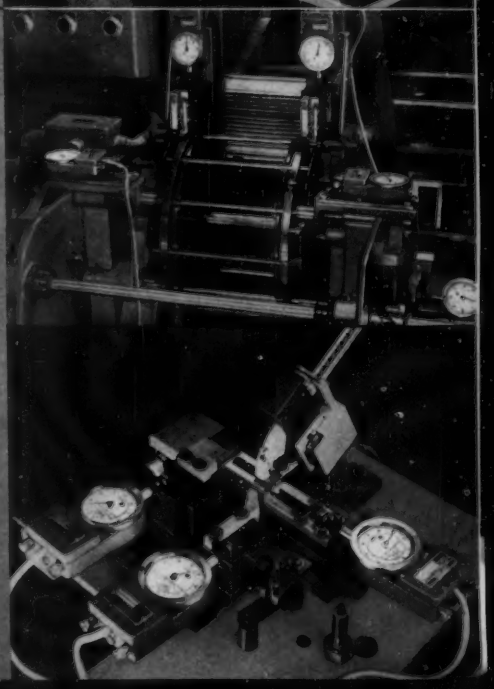


HIGH SPEED AUTOMATIC MULTI-DIMENSION INSPECTION AND MACHINE CONTROL

Electricators have rapid response — can gage and sort up to 6,000 pieces per hour, providing up to 5 sorting categories. Wide range adjustment of limits to suit tolerances. Use of low switching voltage and current provides high-reliability performance.

Electricator can also provide post-process machine control in addition to high-speed gaging and sorting. Using simple control counter, gage automatically stops machine when tolerance limits are exceeded.





Use Reader Service Card, CIRCLE 7

twist

...IT'S LOCKED

No tools required. Finger-tip pressure alone will instantly remove and replace American Slip Renewable type bushings when held in place by the revolutionary new Un-A-Lok Liner.

Available in either A.S.A. Ground, Unground or Delt-A-Liner O. D. finish, UN-A-LOK eliminates lock screws and holding clamps — makes original bushing layout and installation much easier. Screw hole layout, drilling and tapping operations are eliminated. Time is saved and labor costs are lowered.

Un-A-Lok Liners are listed in the new American Catalog just printed. Write for yours today.

the New *American* UN-A-LOK LINER

Brings Instant Interchangeability to Drill Jig Bushings

American **DRILL BUSHING CO.,** 5107 PACIFIC BLVD., LOS ANGELES 58, CALIFORNIA

TELEPHONE LUdlow 3-1122 / TELETYPE LA 1315

"WORLDS LARGEST INVENTORY OF PRECISION DRILL JIG BUSHINGS"

NEW HUGHES MT-3
AUTOMATES JOB LOT PRODUCTION

The new Hughes MT-3 replaces from three to six conventional machines. It drastically reduces costs by bringing production line efficiency to small lot manufacturing of parts requiring face and other milling operations, drilling, boring, reaming and tapping. Operating from numerical instructions programmed on tape, the system functions completely automatically. The MT-3 has an absolute positioning accuracy of ±0.0005". Its part size envelope is a twelve-inch cube, but in many cases will machine parts up to 12" x 24" x 24".

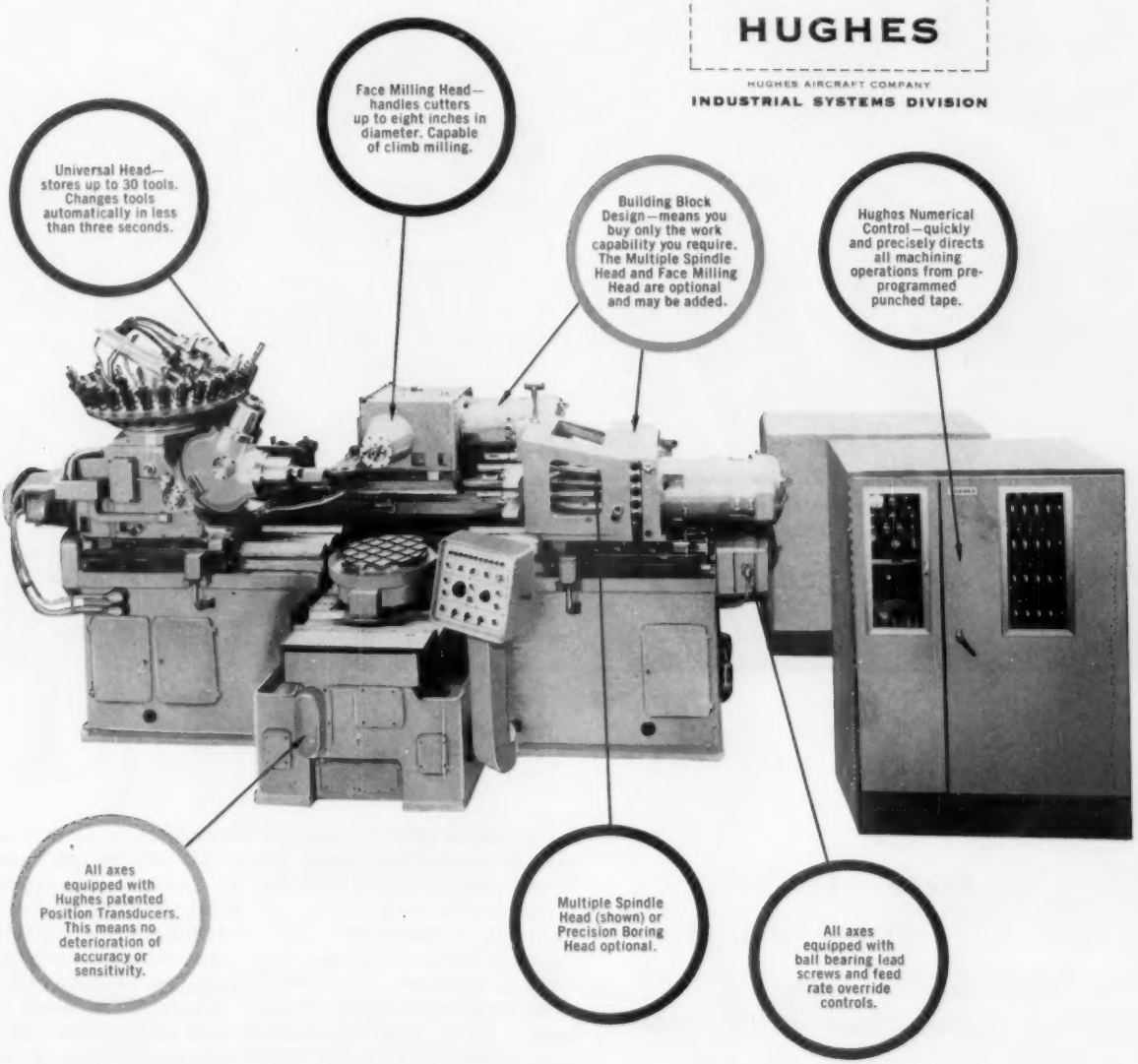
For complete engineering specifications, firm price and delivery dates write, teletype (TWX INGL 4117) or call collect: HUGHES INDUSTRIAL SYSTEMS DIVISION, P. O. Box 90904, Los Angeles 45, California.

CREATING A NEW WORLD WITH ELECTRONICS

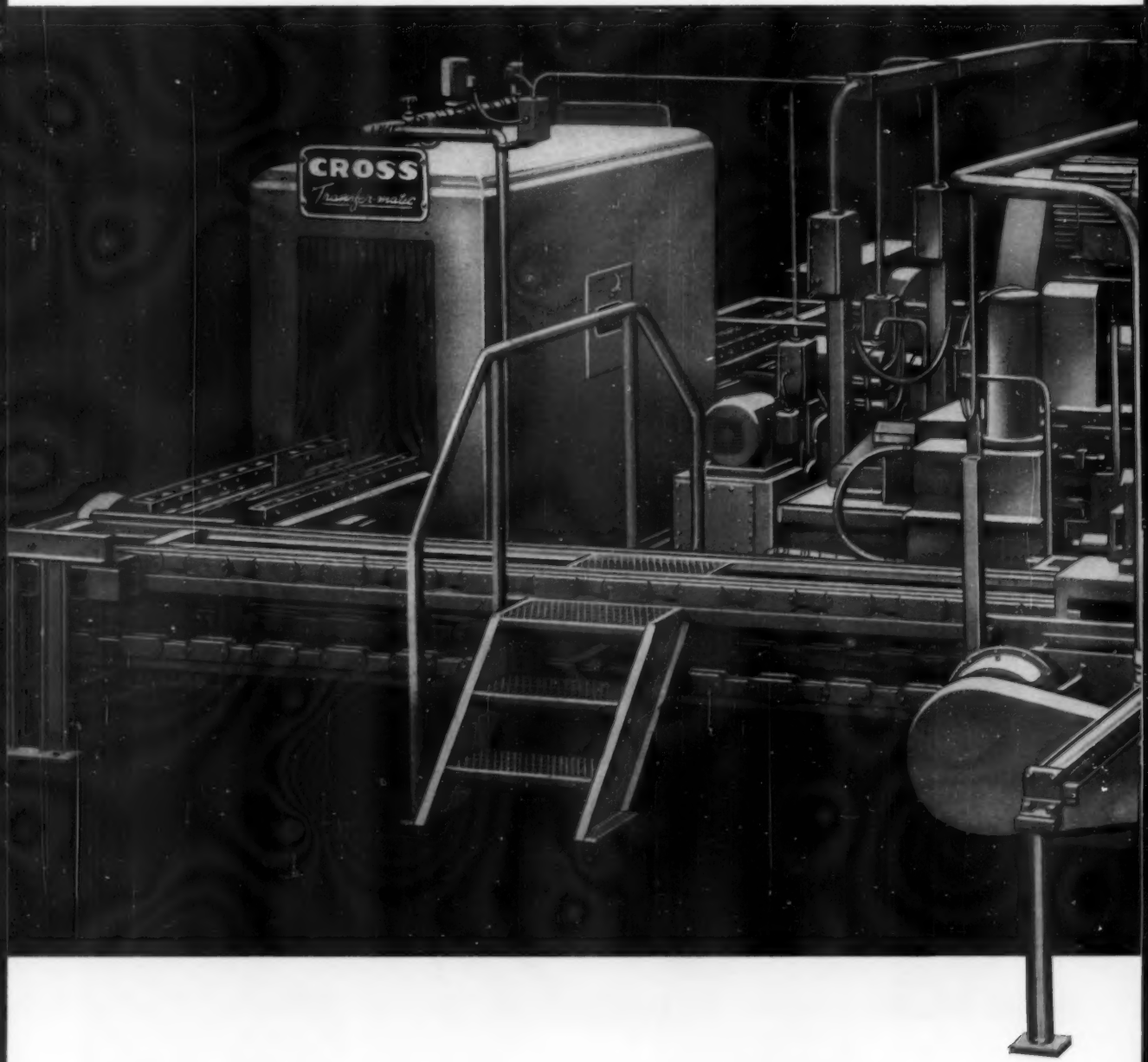
HUGHES

HUGHES AIRCRAFT COMPANY

INDUSTRIAL SYSTEMS DIVISION


Face Milling Head—handles cutters up to eight inches in diameter. Capable of climb milling.
Universal Head—stores up to 30 tools. Changes tools automatically in less than three seconds.
Building Block Design—means you buy only the work capability you require. The Multiple Spindle Head and Face Milling Head are optional and may be added.
Hughes Numerical Control—quickly and precisely directs all machining operations from pre-programmed punched tape.
All axes equipped with Hughes patented Position Transducers. This means no deterioration of accuracy or sensitivity.
Multiple Spindle Head (shown) or Precision Boring Head optional.
All axes equipped with ball bearing lead screws and feed rate override controls.

Completely Machines Tractor Axle Housings

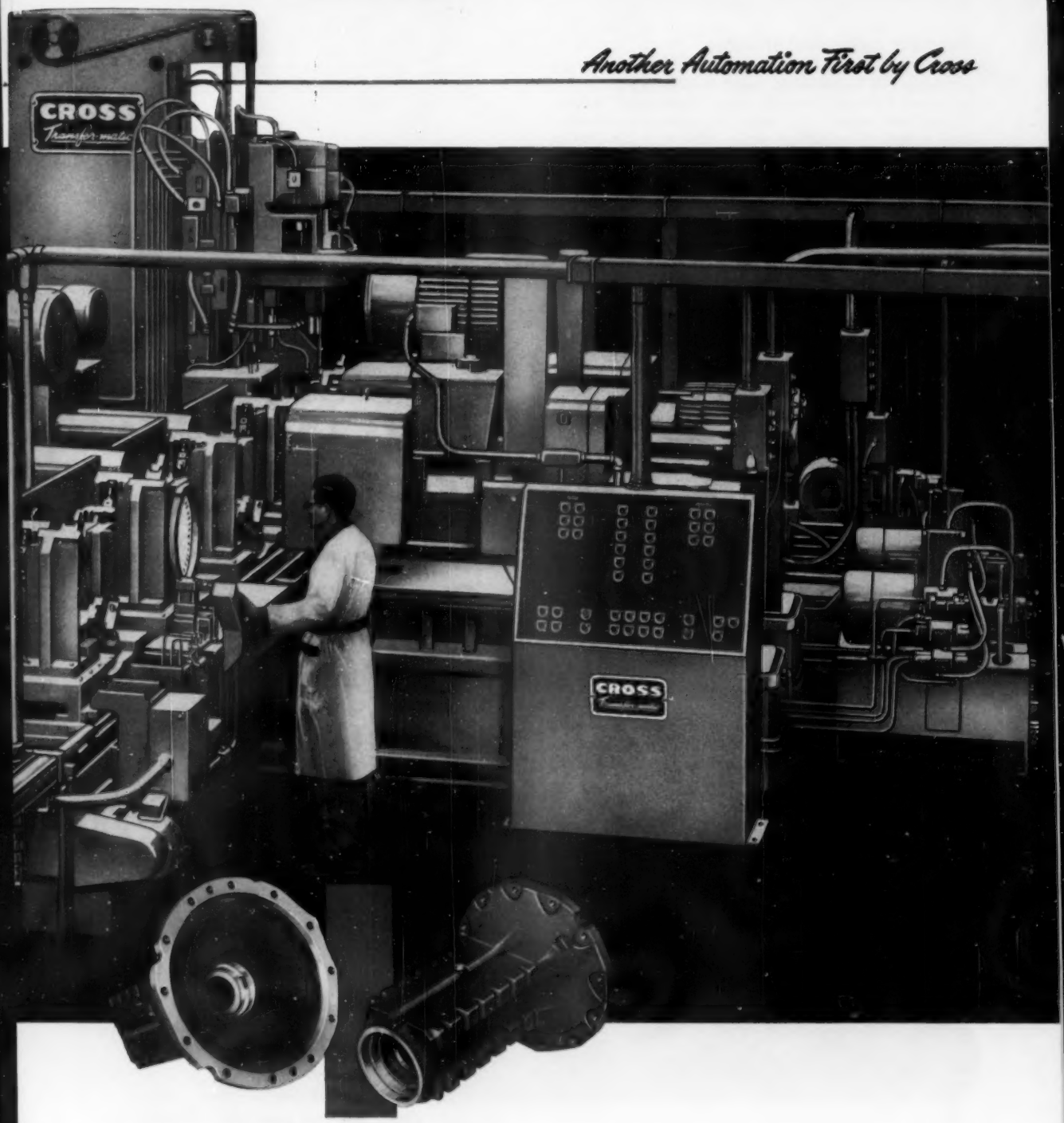


Assures Concentricity and Squareness of Bearing Seats, Counter-Bore and Mounting Flange

A significant breakthrough in processing of tractor rear axle housings has been accomplished by this new Transfer-matic which performs all machining operations.

An outstanding advantage of the machine is greater accuracy. Concentricity and squareness of the bearing seats, counter-bore and mounting flange are assured. Bore tolerances are ±0.0005. The concentricity, squareness, and center-distance tolerances between the bearing seats, faces and dowels is ±0.001. Close alignment between the two ends is maintained by doing all precision boring and the facing on both ends in one station.

Another Automation First by Cross



Four different housings weighing up to 175 pounds are processed with minor adjustments. Production requirements are up to 28 per hour for any of the four parts.

An unusual feature of the Transfer-matic is the use of two shuttle heads that index so that successive operations can be performed without moving the part. This design reduces the amount of capital investment required.

A Cross Sales Engineer will be glad to elaborate on these and other Cross developments.

Established 1898

THE **CROSS** CO.

First in Automation

PARK GROVE STATION • DETROIT 5, MICHIGAN

Use Reader Service Card, CIRCLE 11

From Norton... Higher Speeds for Faster Grinding ...Cylindrical or Surface

For your cylindrical grinding

. . . Norton brings you cylindrical grinders which provide a new higher wheel speed of 8500 SFPM. In test after test Norton Machines using "high-speed" Norton wheels have proved their ability to operate at this new high speed — safely, steadily and with production advantages never obtained before.

These Norton cylindrical production grinders — now called the Series 8500, and so identified with a name plate — include the Type CTU Cylindricals, Angular Wheel-Slide grinders, No. 2 Centerless and the Type CP-1 PLUNG-O-MATIC®. Similarly, Norton high-speed wheels have been tested and approved for 8500 SFPM and carry the new checkered-flag stencil.

Remember: *it took a great deal more than stepping up spindle speeds to assure the greater productivity of Series 8500 machines.*

Fluctuations in wheel energy, mechanical energy, tangential force and many other factors had to be carefully considered before final approval of designs.

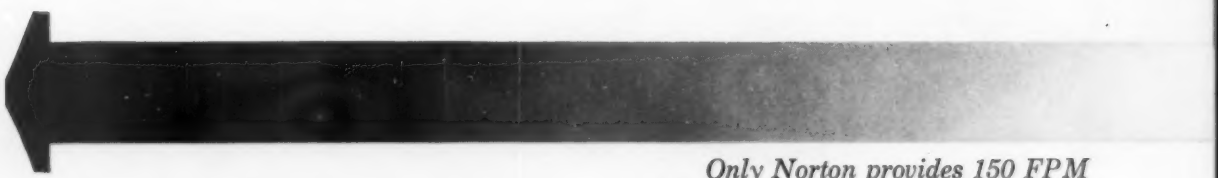
As a result, Series 8500 grinders produce more pieces-per-hour at lower cost-per-piece . . . provide finer finishes for improved product quality . . . and their higher speed reduces wheel dressings for longer wheel life and lowered wheel cost.

For your surface grinding

. . . Norton Type S-3 hydraulic surface grinders are now available with table speeds stepped up to a new high of 150 FPM.

This is another Norton achievement to bring you faster production than ever before. And, like the Series 8500, the Type S-3's are engineered to provide better production and product quality as a benefit of higher table speed.

Available in 6″ x 18″ and 8″ x 24″ sizes, Type S-3 surface grinders are fast and accurate on long production runs or toolroom grinding. They handle taller workpieces . . . are equipped for fast positioning, better sighting and loading . . . and their faster table speeds mean less heat damage to workpieces.



Only Norton provides 150 FPM table speeds on surface grinders.

Learn how Norton developments are bringing more and more advantages of the speed age to many types of grinding. And call your Norton Man — a trained Grinding Engineer — for details on how these advantages can be brought to your own production. Or write to NORTON COMPANY, Machine Tool Division, Worcester 6, Massachusetts.

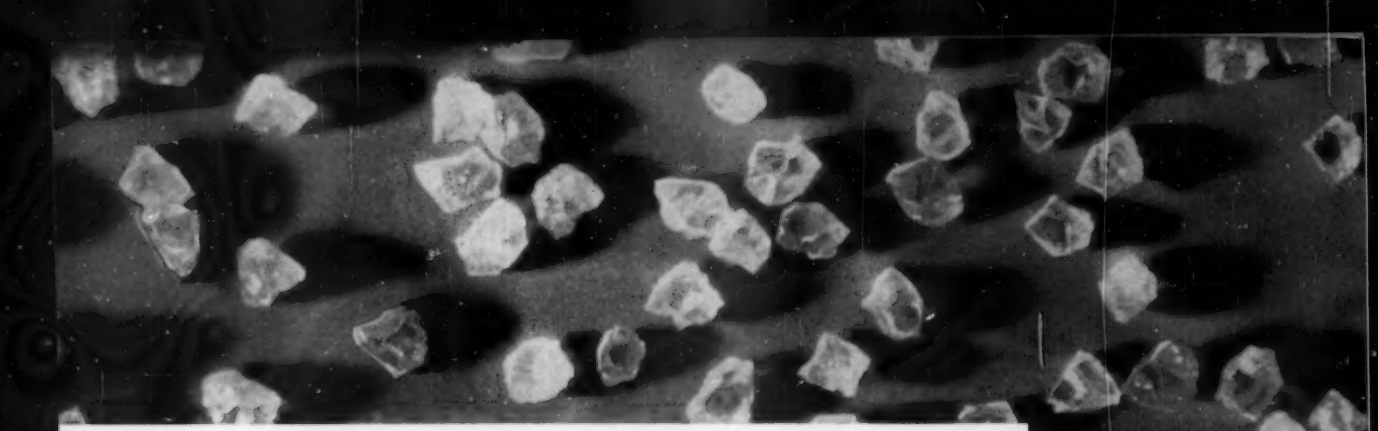
District Offices: Worcester, Hartford, Cleveland, Chicago, Detroit. *In Canada:* J. H. Ryder Machinery Co., Ltd., Toronto 5.

NORTON
MACHINE TOOLS

75 years of... Making better products
...to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — BEBR-MANNING DIVISION: Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes
MACHINE TOOL DIVISION: Grinding and Lapping Machines — G & E DIVISION: Shapers • Gear Cutting Machines • Gear Induction Hardeners

New Natural Diamond Grit Increases Grinding Efficiency In Metal-Bond Wheel Applications



A new member of the SND (Selected Natural Diamond) family, SND-MB (Blocky), with significant superiority in metal-bond wheel applications, is now available.

A unique shape selection and pressure process has made this new natural grit possible. Only particles of predominantly blocky shape are selected, since research and field applications have shown that in metal-bond wheels blocky shapes are stronger and more resistant to abrasion. The result of this new process is a natural diamond grit which can be retained longer in the bond, thereby increasing grinding efficiency in metal bond-wheel applications.

SND-MB (Blocky) is available in mesh sizes ranging from 16/20 to 325/400. Larger sizes are used in heavy-duty applications such as concrete and stone cutting. Smaller sizes are used in metal-bond wheels for grinding and cutting such materials as glass, ceramics, and reinforced plastics.

Investigate SND-MB (Blocky) Today!

Contact your diamond wheel manufacturer and specify SND-MB (Blocky). Through the Industrial Diamond Division of Engelhard Hanovia, Inc., this newest natural diamond grit is immediately available in most sizes for a wide range of applications.

The Field Engineering Staff of the Industrial Diamond Division is available to assist with your natural diamond problems. Call them or your diamond wheel supplier today.

Other Services Available to You

Other services of the Industrial Diamond Division of Engelhard Hanovia, Inc., are the research and development programs continuously underway at the Diamond Research Laboratory in Newark, N. J. These programs supplement the production assistance available to you and your suppliers through the Industrial Diamond Division's Field Engineers. For your convenience, field offices are located in Boston, Chicago, Cleveland, Detroit, Los Angeles, New York, and Newark.

Technical Information Service

Keep abreast of the latest developments in industrial diamond technology through Diamond Data, and the Technical Bulletin service of the Industrial Diamond Division. To receive your personal copies of these valuable technical aids, simply send us your name, title and company address. No cost or obligation.

60-H

SND

SELECTED NATURAL DIAMONDS

ENGELHARD HANOVIA, INC.

INDUSTRIAL DIAMOND DIVISION

113 ASTOR STREET • NEWARK 2, NEW JERSEY

NEW FROM GARDNER-DENVER

Series No. 1 reversible air-tool line to speed production fastening

New Gardner-Denver Series 12E1R reversible screw drivers—both in-line and angle types—speed production fastening of machine screws No. 0 thru No. 6. Series 16E1R nut setters—in-line and angle—also available for machine screw nuts No. 0 thru No. 6.

Here's the new line of reversible air tools you asked for . . . one designed to make production screw driving and nut setting faster than ever before.

Reversible feature saves man-hours—assures accurate driving and setting. Permits tightening of both right- and left-hand rotation screws and nuts with only one tool.

Exclusive "suction pickup" is designed especially for use with non-magnetic fastenings. Vacuum created in the finder or socket picks up and holds screw or nut prior to fastening.

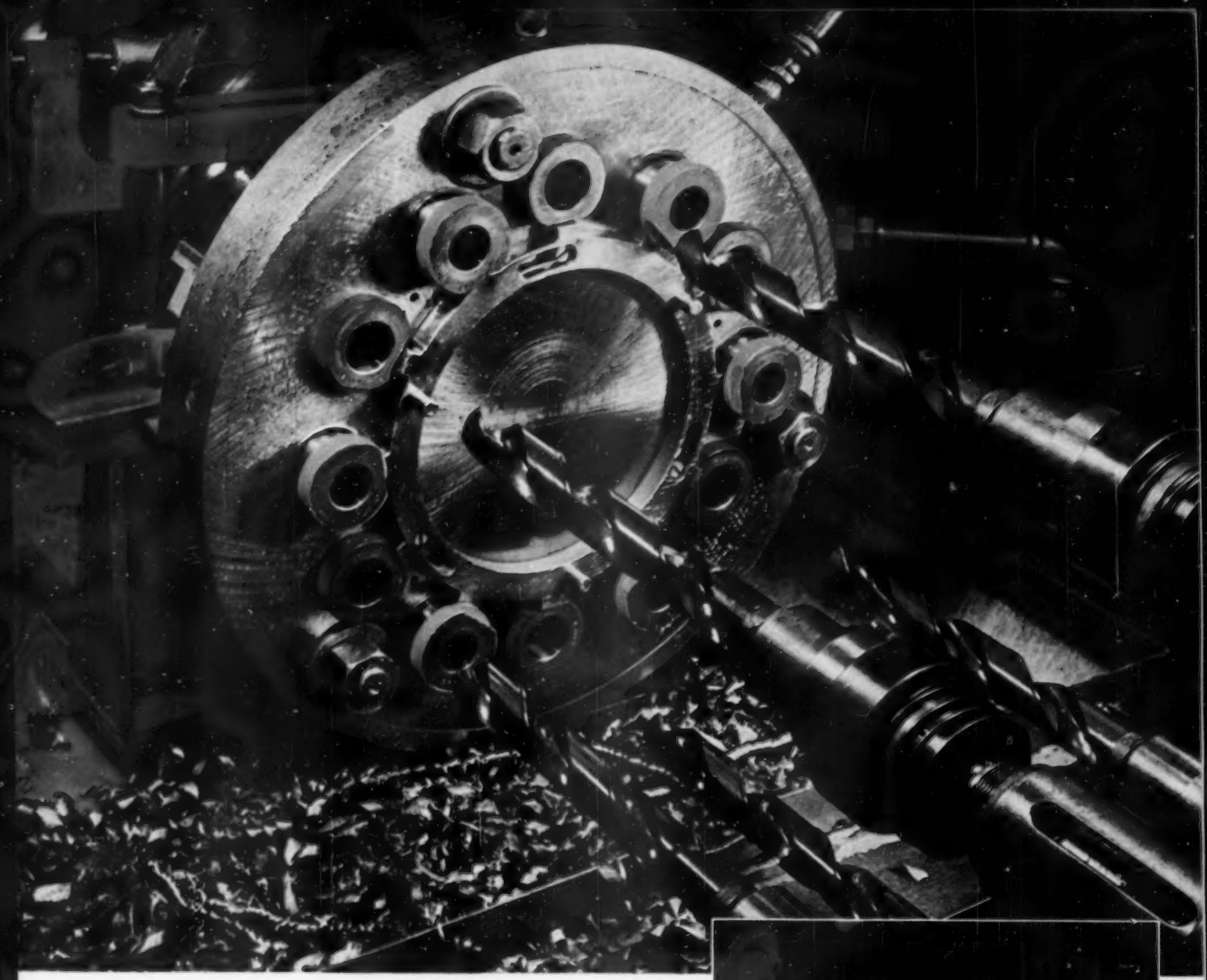
Interchangeability Screw drivers or nut setters—both in-line and angle-types—are available with a complete selection of interchangeable attachments.

For further information consult your Gardner-Denver air-tool specialist or write for new bulletins.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario



HIGH SPEED PRODUCTION
requires drills of *highest quality*

CLE-FORGE High Speed Drills produce more holes per grind . . . faster . . . and at lower cost. They do this consistently, on job after job, because of the QUALITY which is built into them. From the selection of the proper steel, through each manufacturing operation and many inspections, no effort is spared to make them the finest and most economical drills you can buy.

TELEPHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR
for CLEVELAND ◇ Quality Tools . . . *prompt delivery from stock*

© 1960 All rights reserved

One of many heat treating furnaces, where time and temperature are precision controlled to assure highest quality in CLE-FORGE High Speed Drills.

THE CLEVELAND TWIST DRILL CO.

P. O. Box 6656 · 1242 East 49th Street · Cleveland 1, Ohio

Stockrooms: New York Area (Englewood Cliffs, N. J.) • Atlanta • Cleveland • Detroit
Chicago • Dallas • Los Angeles • San Francisco

Skilled craftsmen, using the most modern equipment, insure that BAY STATE Taps measure up to highest quality standards.

It takes *rugged tools* to tap 25,000 HOLES PER HOUR

BAY STATE Taps have the strength and stamina to reduce costly down-time on the high speed set-up shown above. Their built-in QUALITY is your assurance of dependable performance on all jobs, whether large or small. Every step in their manufacture is quality controlled to meet your most exacting requirements for high productivity and long tap life.

TELEPHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR

for BAY STATE Quality Taps and Dies . . . *prompt delivery from stock*

© 1960
All rights reserved

BAY STATE
TAP and DIE CO.

MANSFIELD, MASS. Subsidiary of The Cleveland Twist Drill Co.

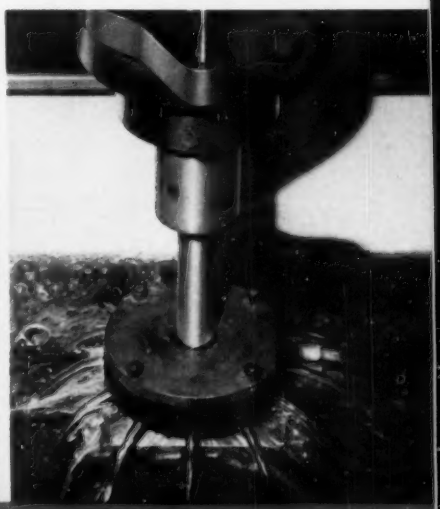
Stockrooms: New York Area (Englewood Cliffs, N. J.) • Atlanta • Cleveland
Detroit • Chicago • Dallas • Los Angeles • San Francisco

CINCINNATI

CINCINNATI offers you 3 types of electrical machining equipment . . .

ELECTRICAL DISCHARGE MACHINES

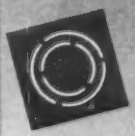
ELECTROLYTIC GRINDING MACHINES



ELECTRO-CHEMICAL MACHINES

Cincinnati builds 22 basic EDM machines, greatly extending the possibilities of this process. Applications include forming, piercing and die sinking on any electrically conductive material, regardless of hardness and fragility, or unusual geometry of the operation. Part shown is copper anode for an electron tube, in which slots were electrical discharge machined. Publication M-2077.

Cincinnati Electrolytic Grinders handle a wide variety of general-purpose and cutter and tool grinding applications, offering substantial savings in grinding wheel costs and in grinding time. Metals that are ordinarily hard to machine or subject to thermal damage can be handled easily and safely because of the "cold machining" nature of the process. Excellent for small parts like the needles at left, which cannot tolerate burrs or metal smear.



For vertical feed, through-hole production applications in hard-to-machine metals. ECM leaves a burr-free surface with no thermal change, opens new areas of cost reduction. Part at left is tough steel, ¼" thick, in which narrow circumferential slots were machined by the electrochemical process.

There are three general classifications of electrical machining, each having particular advantages that solve production problems across the complete field of metalworking. Cincinnati Milling builds equipment for all three, and is prepared to show you the potential for widening design horizons and reducing costs in your shop.

Which Electrical Machining Process is best for you? *Cincinnati has the knowledge and experience to apply the right process to solve your particular machining problem. We will appreciate the opportunity to tell you more.* MILLING MACHINE DIVISION, THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO.

Use Reader Service Card, CIRCLE 19

KNEE TYPE AND BED TYPE MILLING MACHINES • DIE SINKING MACHINES • CUTTER AND TOOL GRINDERS • ELECTRICAL DISCHARGE MACHINES

CINCINNATI®

MILLING MACHINE DIVISION

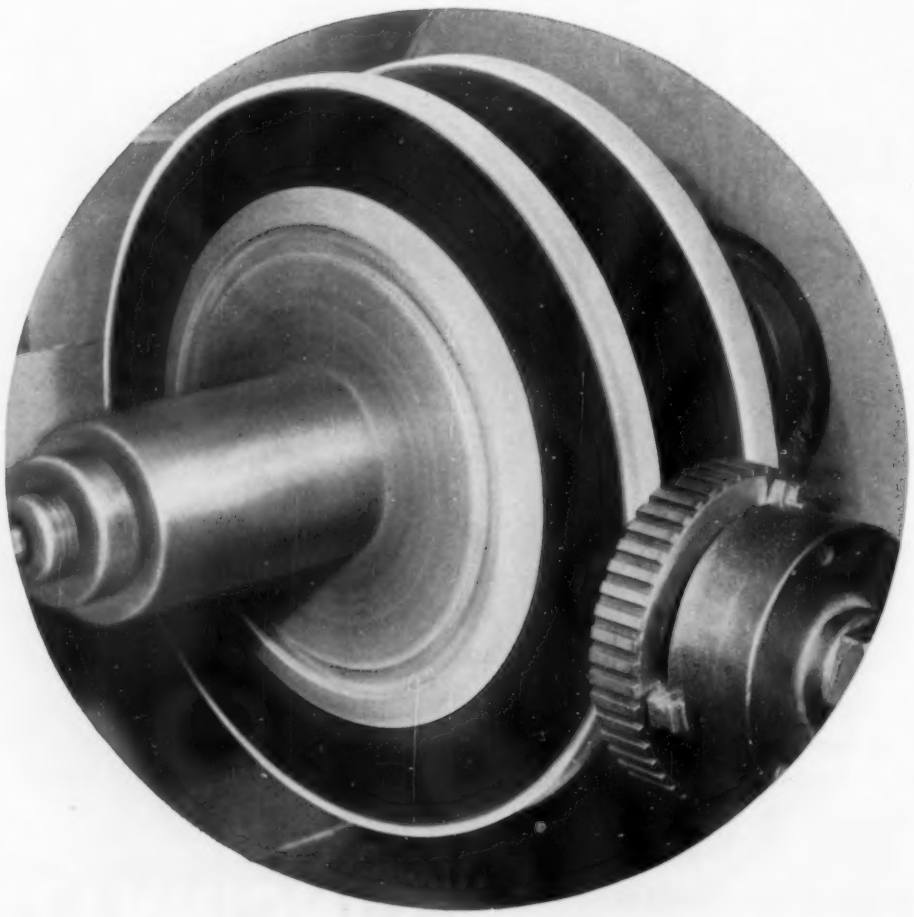
BREAKTHROUGH IN METAL FINISHING! NEW OSBORN MASTER BLEND* BRUSHES . . . a totally new kind of power brush . . . in construction . . . in the unusually wide range of metal finishing jobs it can accomplish . . . in extra service life. You have never used a power brush like this before! • MASTER BLEND features fast-action straight wire cutting points blended with a tough plastic bond. Result: an exceptional precision power brushing tool that goes far beyond any brush you've ever used • Keeps its sharp profile for precision control over the working area throughout its long service life. Won't flare out • Scores big advantages over other accepted finishing methods. Can't rip or tear. Won't load up • Has extraordinary cutting power. Edge-blends and deburrs perfectly. Peening is kept to an absolute minimum, and—in many cases—is entirely eliminated. No compound required • Finishes more parts per hour, more parts per brush. Two years of research and on-the-job tests proved it. MASTER BLEND will outperform . . . outlast . . . any other power brush available. **FREE BULLETIN MB-100** includes MASTER BLEND Brush sizes, types, applications. Write or call *The Osborn Manufacturing Company, Dept. K-65, Cleveland 14, Ohio. Phone ENdicott 1-1900.*

breakthrough

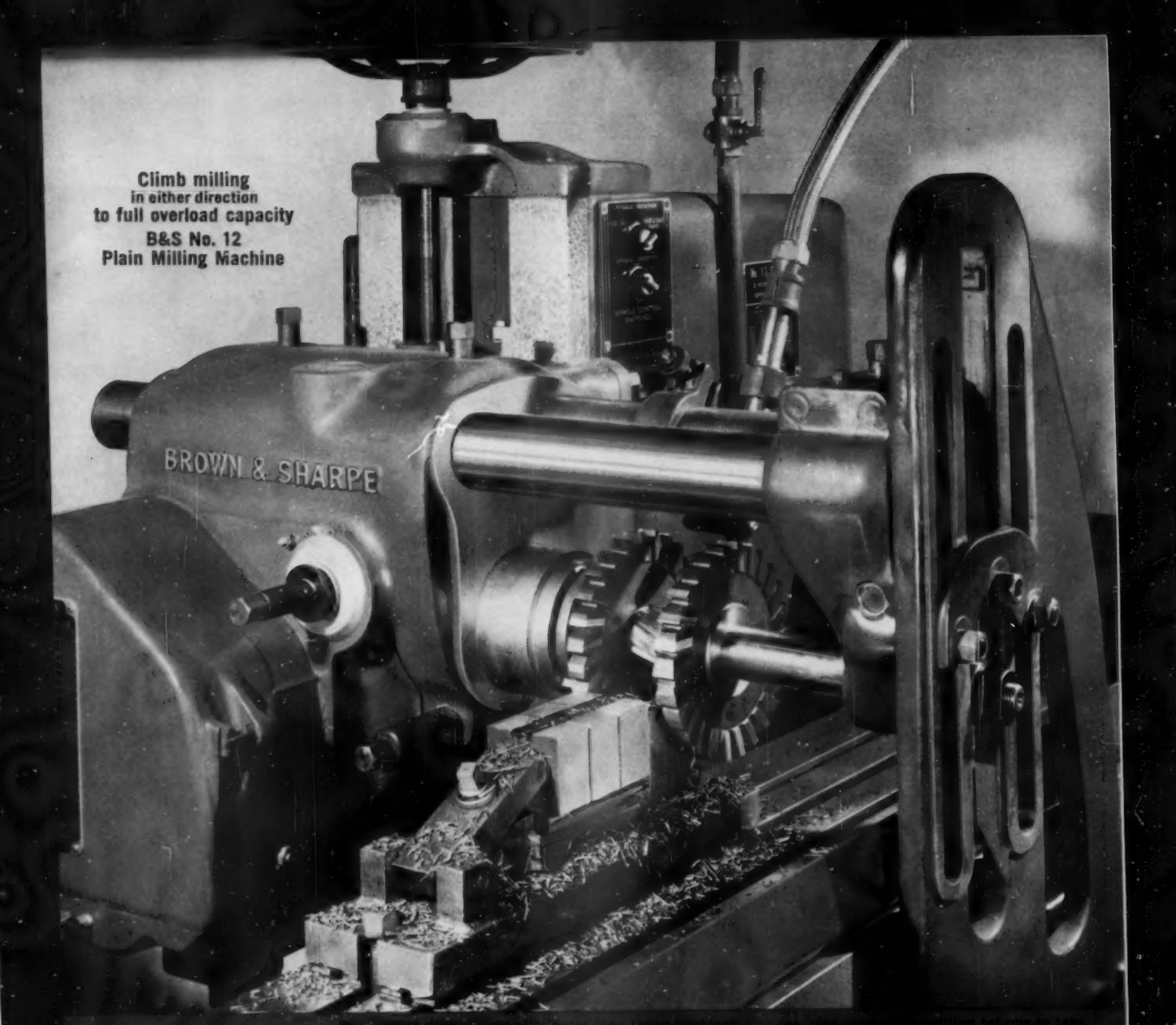
★ Trademark

Metal Finishing Machines . . . and Finishing Methods
Industrial Brushes • Foundry Production Machinery

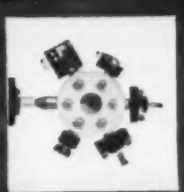
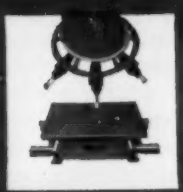
OSBORN

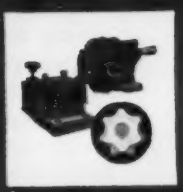
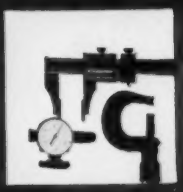


20 Use Reader Service Card, CIRCLE 20 Use Reader Service Card, CIRCLE 21



STAR PERFORMERS at the CHICAGO EXPOSITION

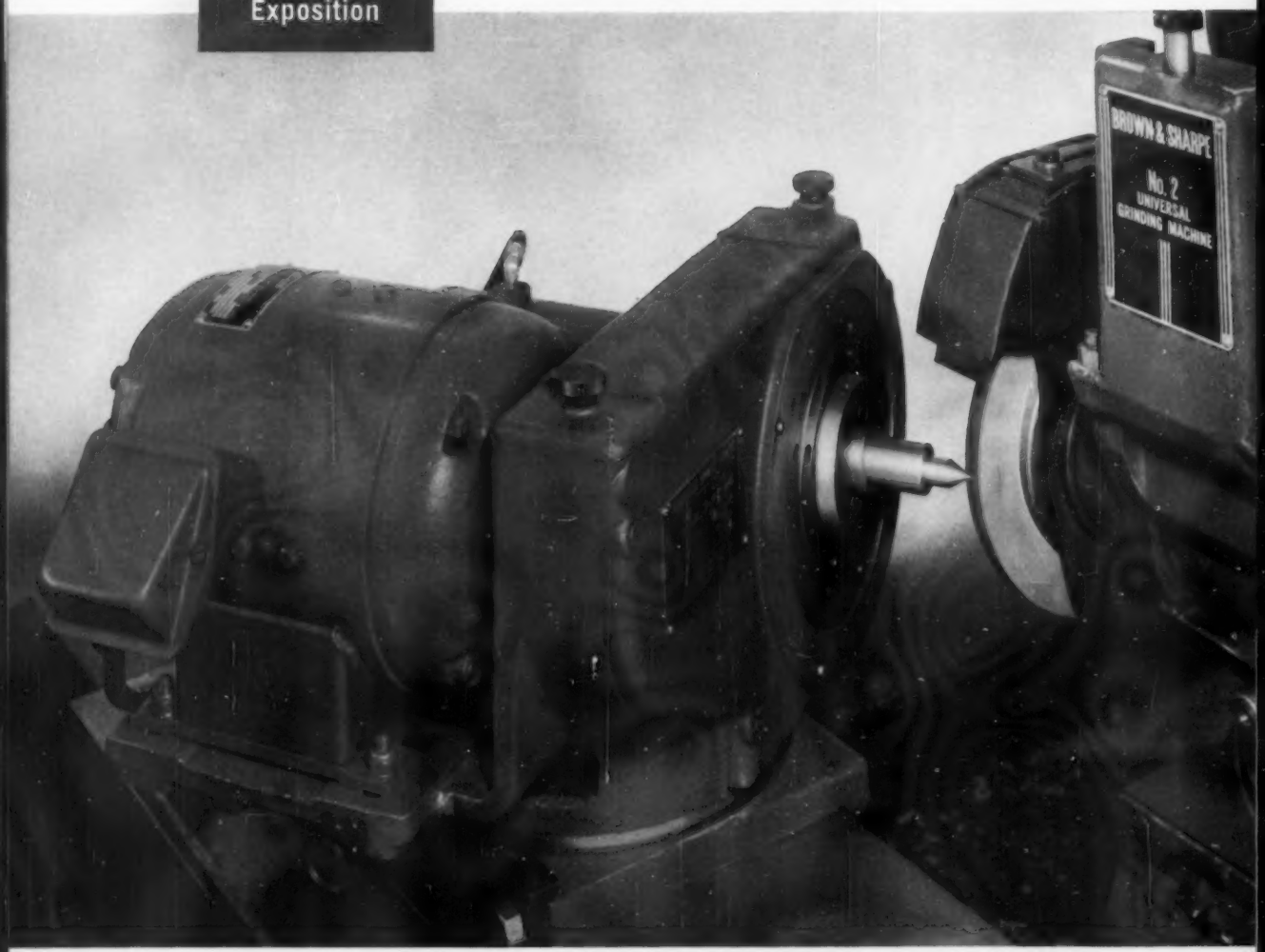



to help you make more for less...

Brown & Sharpe

STAR PERFORMERS at the Chicago Exposition

TO HELP YOU GRIND MORE FOR LESS



New Supercise Headstock for B & S Universal Grinders repeats size and roundness within ten millionths

Test chart indicates true roundness within 5 millionths of an inch.

With this new B&S designed hydrostatic headstock, grinding to split-tenth precision in size and roundness, with super-finish, can now be maintained in production runs, with average operators. The unique hydrostatic bearings automatically compensate for minute errors and assure accuracy well beyond the limitations previously considered normal. Contact wear of the spindle is virtually eliminated, and accuracy is maintained through years of constant use.

The Supercise headstock is available as special equipment on the No. 2, 3 and 4 Universal Grinding Machines. It adds another to the many exclusive features of B&S Universal design that frequently permit job-time savings of 75% or more.

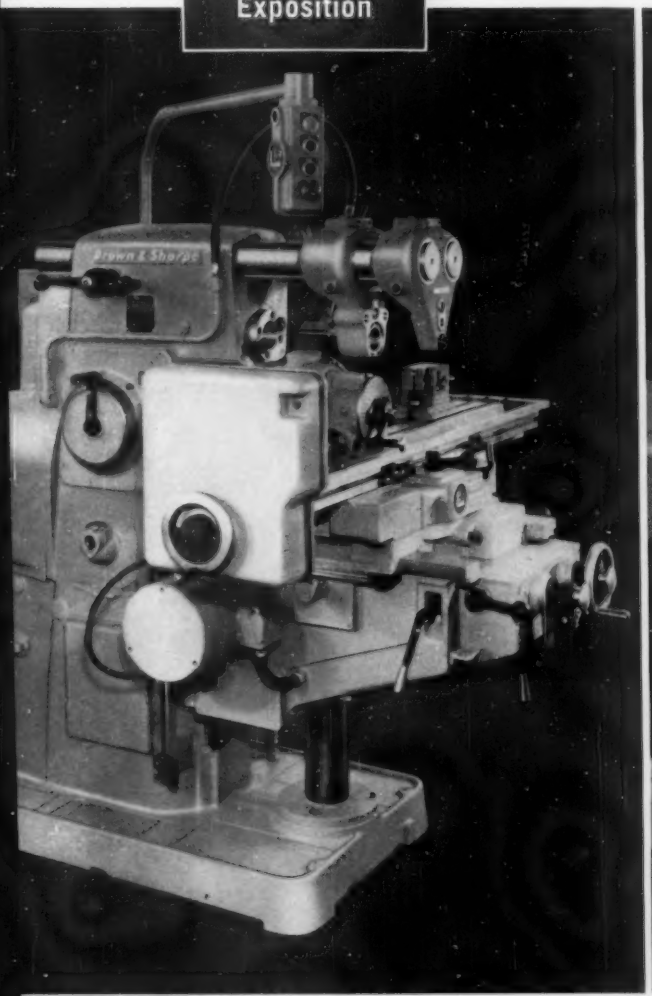
You need all these extra B&S design advantages, when you select Universal Grinders for toolroom, prototype operations, or production grinding. Why settle for less? For details write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

Brown & Sharpe PRECISION CENTER

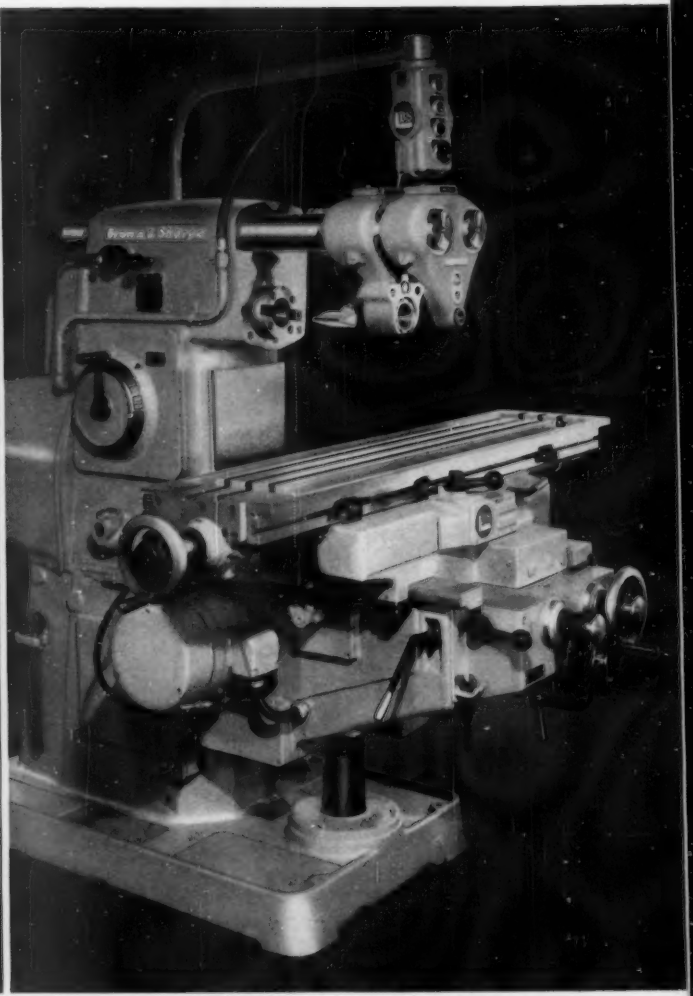
Use Reader Service Card, CIRCLE 22

STAR PERFORMERS at the Chicago Exposition

TO HELP YOU MILL MORE FOR LESS



NEW B&S No. 2 Universal Milling Machine



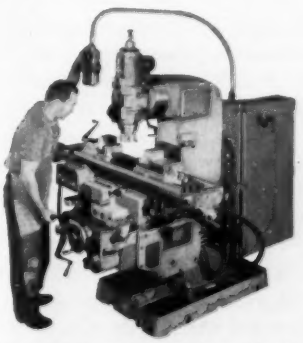
NEW B&S No. 2 Plain Milling Machine

New DYNAMASTER design "tailors" machine to fit the job - you buy only needed features - from 132 combinations

The Brown & Sharpe DYNAMASTER series is an entirely new concept in knee-type milling machine design. You can order any of 132 combinations of standard features, in 14 models of Plain, Universal, Vertical, and Rangemaster. You can also select the drive you need — 3, 5, 7.5 or dual 10/5 HP.

In every DYNAMASTER, you get heavier, balanced construction that puts the weight where it's needed — permits you to take full advantage of the fast-cutting potential of carbide and coarse-tooth cutters. Hydraulic gear shifting, and many other control improvements, set new standards of operating ease and simplicity.

Before you invest in milling equipment, get the complete story of the 27 design improvements, with 9 important advantages available only in a DYNAMASTER. For toolroom — maintenance — prototype work — short or long run production — the dollar-wise buy is a DYNAMASTER. For details, write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, R. I.



NEW B&S No. 2 Vertical Milling Machine

Brown & Sharpe PRECISION CENTER

Use Reader Service Card, CIRCLE 23

STAR PERFORMERS at the Chicago Exposition

TO HELP YOU DRILL AND TAP MORE FOR LESS

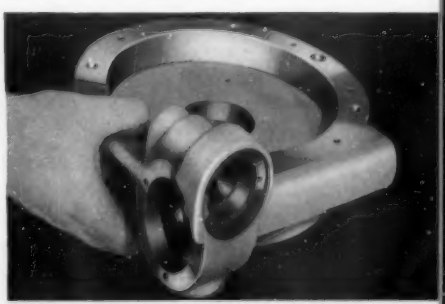
New B&S trunnion fixture with index head (right) permits fast, accurate positioning for holes in any pl

Drill, tap, bore, ream with .001″ hole locating precision - 2 to 5 times faster – with B&S Turret Drilling Machines

Multiple drilling operations at a single station, and fast, accurate hole location without expensive jigs — these are only two of the major advantages of the Brown & Sharpe Turret Drilling method. For large, as well as small parts, you can reduce production drilling costs up to 80% or more.

With a B&S Positioning Table and simple holding fixtures, accurate hole location (within .001″) takes only a few seconds in each sequence. On the B&S Model A Turret Drilling Machine, you can machine any hole pattern within a 24″ circle.

Find out how much you can save — in handling time, set-up time, capital investment, floor space, and maintenance. Send your parts and drawings for a free estimate of savings with turret drilling. Write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, R. I.



67 operations, 23 holes, in 4 planes . . . time: 10 min. 40 sec.

B&S Positioning Tables are also sold separately for other machining needs. Write for details.

Brown & Sharpe PRECISION CENTER

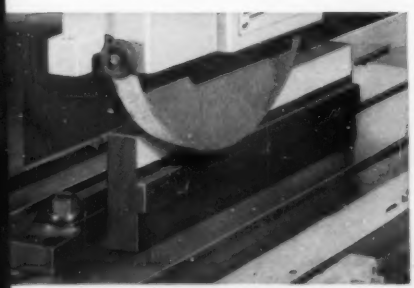
Use Reader Service Card, CIRCLE 24

STAR PERFORMERS at the Chicago Exposition

TO HELP YOU GRIND MORE FOR LESS

New Brown & Sharpe 1030 MICROMASTER Surface Grinding Machine

New profit-saving Surface Grinders for larger work - the B&S 824, 1024 and 1030 MICROMASTERS



Elimination of saddle (no table twist) assures accurate grinding of parallel, vertical surfaces.

Ever since the introduction of the 618 MICROMASTER, demand has steadily increased for larger capacity B&S Surface Grinders with the same profit-saving, super-precision performance. Now, they are ready — in 8″ x 24″, 10″ x 24″, and 10″ x 30″ sizes. You get full hydraulic control with table speeds from 10 to 125 fpm, and a generous 14½″ capacity under a 12″ wheel.

The broad based, rugged construction assures lasting precision to ten-thousandths, and flawless microinch finishes. You can choose the 5HP direct drive, or the 3HP Oriflex drive, according to your needs. All basic controls are at the operator's fingertips.

You can order your MICROMASTER with any of a wide selection of optional equipment, or factory-modified to give you exactly the machine you need. Why settle for less — or more?

For full information, write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, R. I.

Brown & Sharpe PRECISION CENTER

Use Reader Service Card, CIRCLE 25

The way Pipe Machinery's Correlchek Inspects NPT, ANPT, NPTF and NGT Threads

Here's an amazingly fast, accurate method for checking the pitch diameter, crest truncation and root truncation of precision pipe threads (internal and external).

You simply set the instrument with master gages using your present gage members — then presto — check your fitting to the proper tolerances indicated by color zones on the dial. There's nothing to remember — nothing to figure out. The Correlchek does all your thinking for you . . . completely eliminates any chance for human error!

For more detailed information on this wonder working Pipe Machinery gage, write us on your company letterhead today.

THE PIPE MACHINERY COMPANY 29100 Lakeland Boulevard • Wickliffe, Ohio • Greater Cleveland

Use Reader Service Card, CIRCLE 26

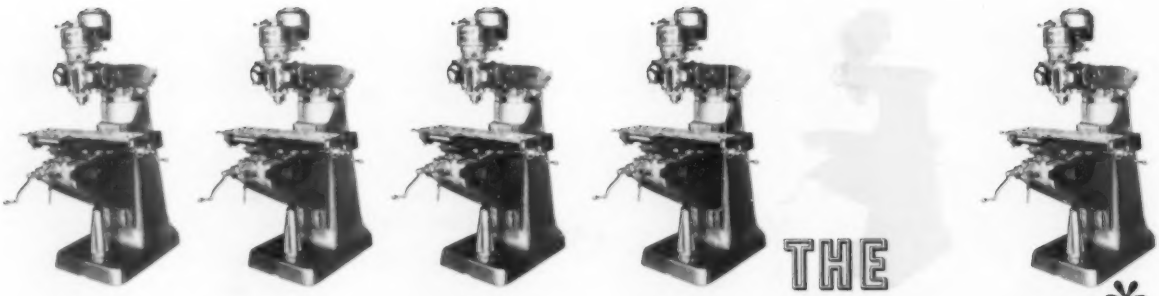
Use Reader Service Card, CIRCLE 27

Bridgeport's 50,000th *"Anniversary"*

Our "Anniversary"
is measured
in production -- not time.
This 50,000th
Bridgeport Turret
Milling Machine,
completed on July 6, 1960,
was finished in gold
to commemorate
the occasion.

Cost . . . Versatility . . . Reliability
These are the factors influencing
the decision to purchase a
machine tool. 50,000 decisions
favored Bridgeport Millers . . .
"THE MOST FOR THE LEAST"

***Bridgeport*® MACHINES, INC.**
Bridgeport, Connecticut
Manufacturers of High Speed Milling Attachments and Turret Milling Machines



THE GOLD PLATED* MILLING MACHINE

Completion of the 50,000th Bridgeport Turret Milling Machine, earlier this year, set an international record for production of a single machine tool.

There is more to this outstanding achievement than mere statistics would indicate.

There is the story of a company which stands as proof-positive that American know-how, inventiveness and craftsmanship can produce a machine that has become an integral part of the language of metalworking throughout the world.

This is testimony, also, to the accomplishments made possible by a free economy.

The companies whose products and services contribute to the manufacture of the Bridgeport Miller are proud of the continuing parts we play in the building of this world renowned machine. Its requirement for perfection in every detail has heightened the standards for quality and workmanship to which our products are made.

IN RECOGNITION

MACHINE HANDLES AND BALANCED CRANKS
Balcrank, Incorporated
Cincinnati, Ohio

LUBRICATING SYSTEMS FOR MACHINE TOOLS
Bijur Lubricating Corporation
Rochelle Park, New Jersey

QUILL MASTER & QRA ATTACHMENTS
Custom Machine & Tool Company
Clifton, New Jersey

INDUSTRIAL PAINTS & LACQUERS
C. W. Haynes Laboratories
Springfield, Massachusetts

STEEL SERVICE CENTER
Edgcomb Steel of New England, Incorporated
Milford, Connecticut

BALL BEARINGS
Fafnir Bearing Company
New Britain, Connecticut

ELECTRIC MOTORS
Fairbanks, Morse & Co.
Freeport, Illinois

GEARS
Grant Gear Works, Inc.
Boston, Massachusetts

PRECISION BALL, ROLLER & THRUST BEARINGS
Norma-Hoffman Bearings Corporation
Stamford, Connecticut

ALUMINUM CASTINGS AND DIE CASTINGS
Peerless Aluminum Foundry
Bridgeport, Connecticut

CHROME PLATED WAYS FOR MACHINE TOOLS
The Superior Plating Company
Fairfield, Connecticut

CASTINGS
The Producto Machine Company
Bridgeport, Connecticut

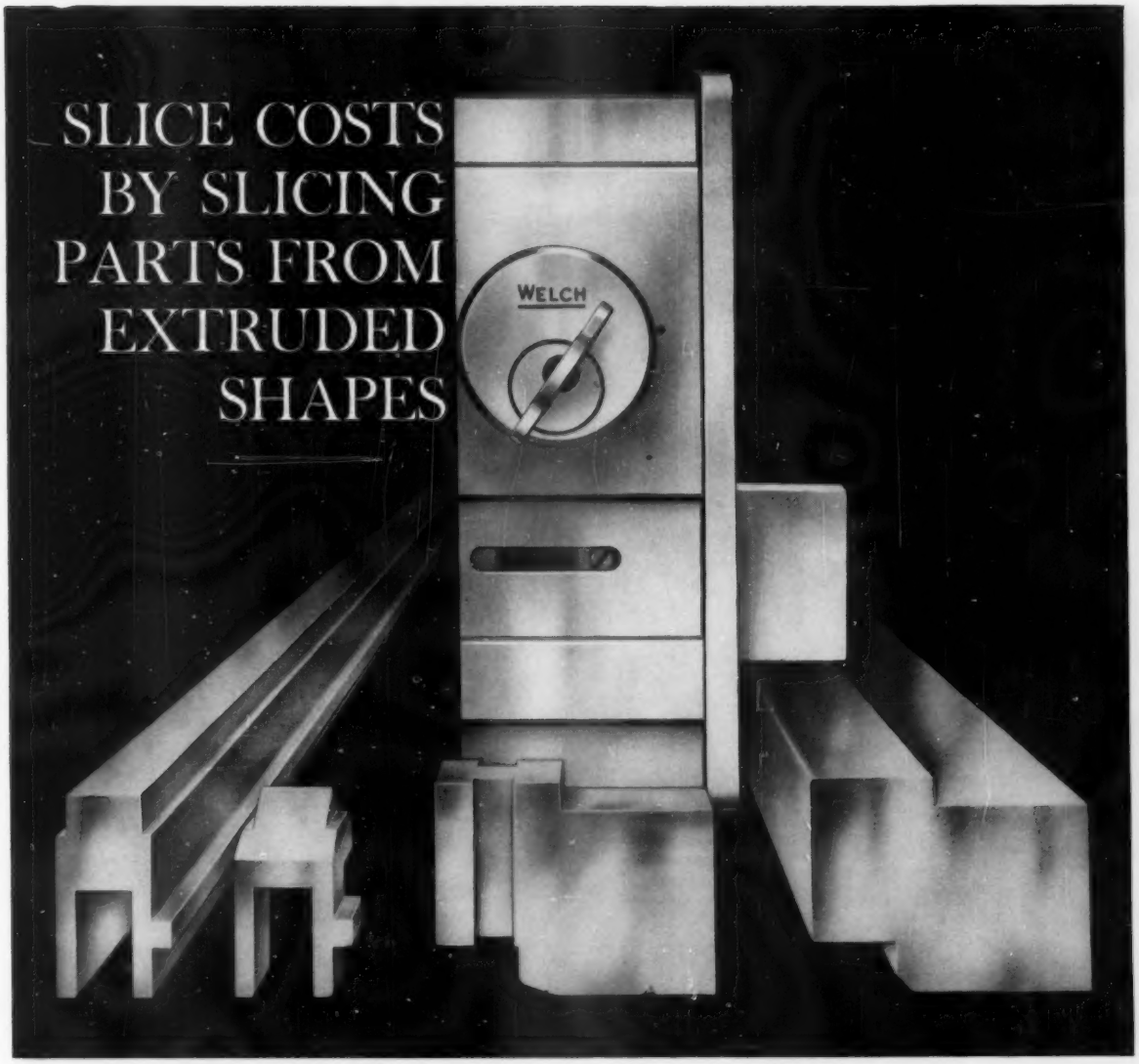
PRECISION MACHINE TOOL CONTROLS
True-Trace Corporation
El Monte, California

ELECTRICAL MOTORS
U.S. Electrical Motors, Incorporated
Milford, Connecticut

OPTICAL MEASURING INSTRUMENTS
Veriscope Corporation
New York, New York

*The 50,000th Bridgeport Miller was finished in "gold" to commemorate its manufacture.

SLICE COSTS BY SLICING PARTS FROM EXTRUDED SHAPES



Fabricating parts from long lengths of "premachined" shapes reduces machining, scrap, and finishing

The lock components shown above are typical of some 20 different precision brass parts which Welch, Inc., Waukegan, Ill., makes for its broad line of locks and latches, from Anaconda extruded shapes.

Welch works closely with Anaconda specialists from early design stages. New lock mechanisms are built around parts which can be cut by a metal slitting saw from long lengths of extruded shapes with minimum subsequent machining and scrap. The use of bar stock is never considered when there is the slightest possibility of designing savings into a part by means of a brass extrusion.

Superior quality, too. Parts made from extruded shapes are characterized by their strong, homogeneous, wrought-metal structure. And the smooth, extruded surfaces reduce many finishing operations.

More and more manufacturers are cutting fabricating costs *and* maintaining quality by using these preformed or, in effect, "premachined" shapes. For imaginative and practical help in adapting extruded shapes to the economical production of intricate parts, call your Anaconda representative or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6044L

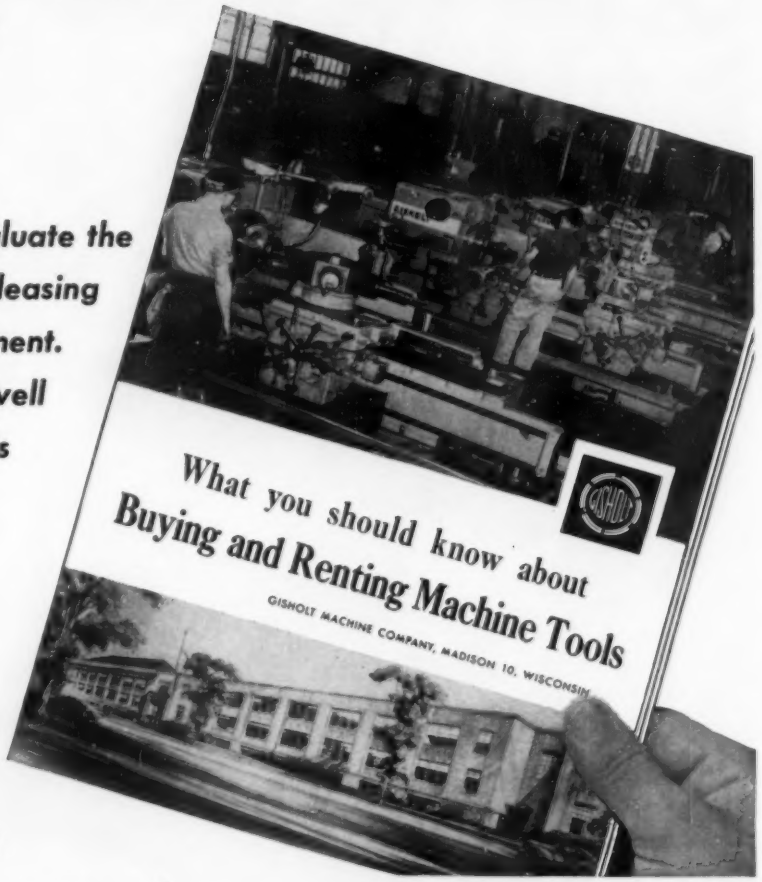
Extruded Shapes • Special-Shape Tubes • Die-Pressed Forgings

ANACONDA®

Anaconda American Brass Company

Can your competitors turn metal at lower costs?

***Now** is the time to re-evaluate the possibilities offered by leasing of new production equipment. Your decision today can well determine your company's position in tomorrow's competitive market.*



This free booklet tells how you can get new machines with minimum capital outlay

If you have delayed replacing old machines because of the relatively large capital investment, acquisition by methods other than outright purchase may solve your problems. Only a minimum initial investment provides you with the many competitive advantages that new machines offer, including greater accuracy, higher production rates and faster setup. New features and accessories simplify even the toughest jobs. Secondary operations are minimized and spoiled work becomes a thing of the past. All this means lower unit cost—more profit for you.

If you want the benefits that new machine tools can provide, and if you like the idea of letting them "pay their way" while they "turn" a profit for you, you'll want to write for Gisholt Bulletin 1173 on buying and renting machine tools. It fully explains one of the most liberal and comprehensive policies in the industry, and covers several types of leasing and time payment plans with vital information on depreciation, tax angles, the MAPI formula and other timely questions. The coupon will bring your free copy. Send it along today.

GISHOLT MACHINE COMPANY
Madison 10, Wisconsin

ASK YOUR GISHOLT REPRESENTATIVE ABOUT FACTORY-REBUILT MACHINES WITH NEW-MACHINE GUARANTEE

Gisholt Machine Company
1227 E. Washington Ave.
Madison 10, Wisconsin

Without obligation, please send your Bulletin 1173.

Name.....*Title*.....

Company.....

Street address.....

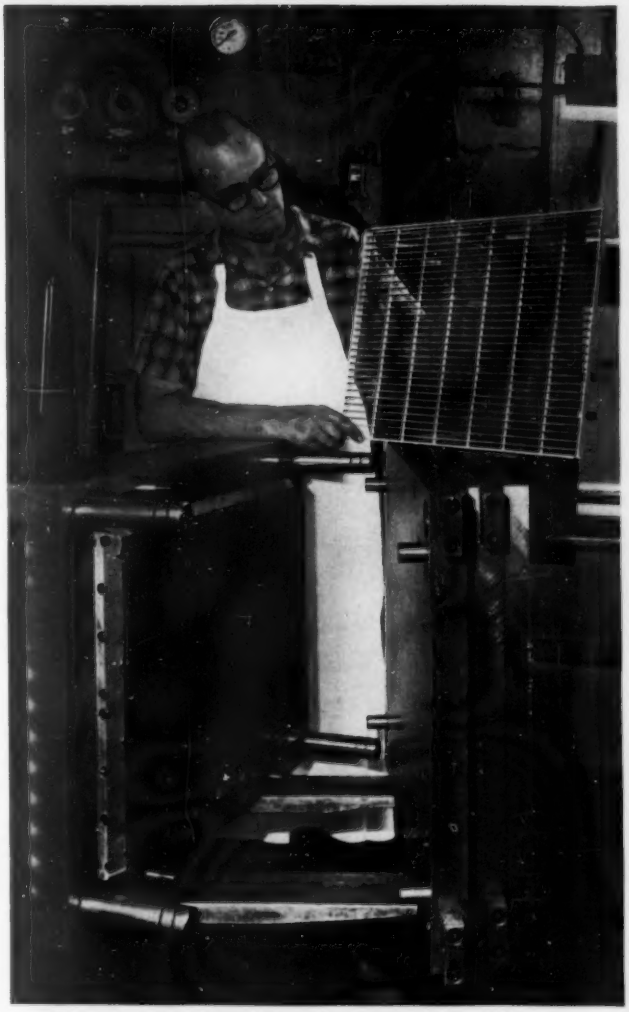
City.....*Zone*.....*State*.....

Tool Steel Topics

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Plastic grille for air conditioner molded IN A BREEZE with Lustre-Die



This plastic grille for an air conditioner was molded at the rate of one per minute by Midwest Plastics Corporation, Wichita, Kansas. Using a die made of Lustre-Die tool steel, they produced a perfectly formed grille, with a high sheen. The grille measures 21½ x 15 in., and is ½ in. thick.

Why Lustre-Die is Ideal for plastic molders

Lustre-Die tool steel is ideal for plastic molders because it can be put right to work, without the need for heat-treatment. It's easy to machine, and it polishes beautifully . . . making possible an eye-appealing sheen on finished plastic parts.

Lustre-Die is an electric furnace steel. It has a well-balanced basic analysis. By adding a special alloy fortification, which increases its depth of hardenability, its fine mechanical properties are further improved. Because Lustre-Die is heat-treated in the mill by means of oil-quenching and tempering, it comes ready for machining and polishing. It is also carefully controlled during manufacture to insure freedom from porosity.

You can always count on a fine molding job when you use Lustre-Die. But don't take our word for it. Put Lustre-Die to work in a trial run. Your Bethlehem tool steel distributor can supply you.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Watch Out for Abrasion Caused by Scale

When punch-press operators are occasionally unable to obtain the required sheet stock in the usual cold-finished form, they substitute hot-rolled stock. However, this causes the service life of the punches and dies to drop to one-half or one-third of normal, or less. This result is largely due to the abrasion of the scaled hot-rolled surface on the cutting edges of the tools. Determining whether such a substitution is economical depends upon the results which are expected, and the cost, of each individual job.

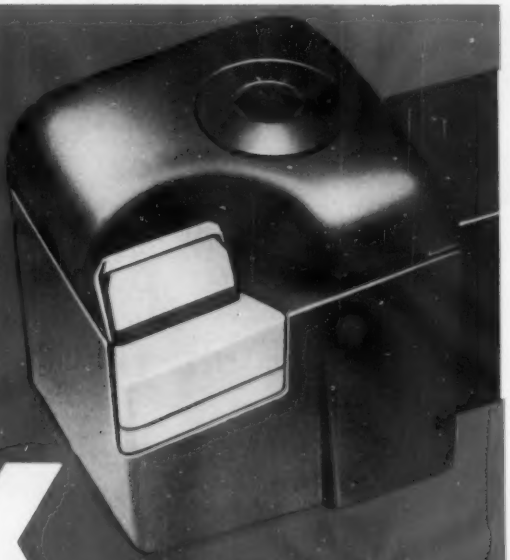
One frequently hears the question: "What can be done in tooling to avoid this decrease in production?"

When punches and dies are normally made from water-hardening carbon tool steel (W-1 or W-2), or from manganese oil-hardening steel (O-1), the shortening of tool life can be avoided by changing to a high-carbon high-chromium tool steel, such as Bethlehem Lehigh H (D-2). This change usually overcomes the disadvantage of using the hot-rolled scaled stock.

However, if high-carbon high-chromium grades are already being used, there is only one method by which an appreciable improvement can be realized—the use of special heat-treatment operations. Typical treatments are short-cycle hardening, and nitriding. Complete details regarding these types of treatment may be obtained by writing Bethlehem Steel Company, Bethlehem, Pa.

Use Reader Service Card, CIRCLE 31

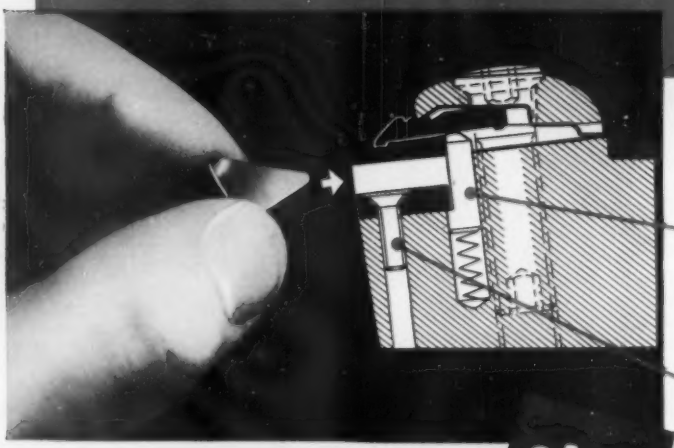
ONLY SANDVIK Coromant



T-MAX

Adjustable Toolholder

Gives You These 3 Cost-Cutting Advantages



1. **LOW INITIAL COST** — for complete toolholder, holds down inventory investment. Triple purpose, solid carbide chipbreaker cuts replacement expense, too.
2. **FASTEST, SIMPLEST CHANGING** — Exclusive "Auto-Lift" pin automatically lifts and holds *both* the three-position chipbreaker and clamp *clear of the insert for fumble-free indexing or replacement.* A simple push clicks the chipbreaker into desired position for light, medium or heavy cut.
3. **"NON-BINDING" SHIM PIN** — Shim held by exclusive tempered spring pin. No screw to freeze or bind from machining heat.

Available in a wide range of styles and sizes in positive and negative rake holders to handle almost any machining job. Send for free catalog or contact your nearest Coromant distributor today.

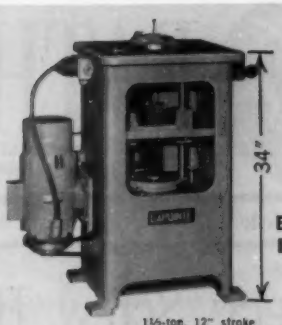
SANDVIK STEEL, INC.

1702 Nevins Road • Fair Lawn, N. J. • Tel. SWarthmore 7-6200
In N. Y. C., ALgonquin 5-2200
CLEVELAND • DETROIT • CHICAGO • LOS ANGELES
SANDVIK CANADIAN LTD. • P. O. Drawer 1335, Sta. O., Montreal 9, P. Q.

SANDVIK

If your production requirements are low-to-high in volume..... you can cut production costs by using these 3 LAPOINTE TOOLROOM SIZE

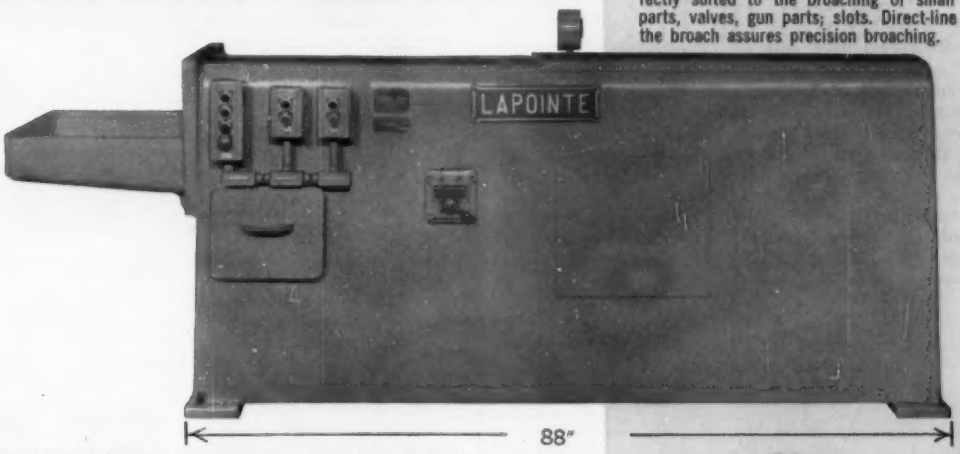
BROACHING MACHINES



EB . . . EAGER BEAVER

1½-ton, 12" stroke

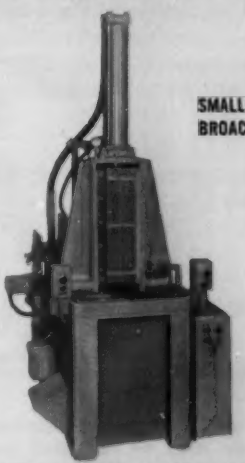
Portable, can be plugged into a 110v outlet. Perfectly suited to the broaching of small missile parts, valves, gun parts; slots. Direct-line pull on the broach assures precision broaching.



HP5 BROACHING MACHINE Available in two strokes: 30" and 48" for internal and surface broaching on a horizontal plane. Here's a universal broaching machine that practically every shop can use and any shop can afford.

Versatility and flexibility are the outstanding characteristics of these small size Lapointe Broaching Machines, all representing the best in Lapointe engineering, and built throughout according to Lapointe quality standards. All are low in price, thus enabling the medium and small size shop — and the job shop — to use broaching . . . wherever it can be shown to have an advantage over milling or some other conventional metal-removing method.

This is your opportunity to consider the advisability of converting to broaching — Lapointe Broaching — for the many production advantages you will gain. (One of these is the elimination of scrap!) A qualified Lapointe Field Engineer will gladly discuss broaching with you on request.



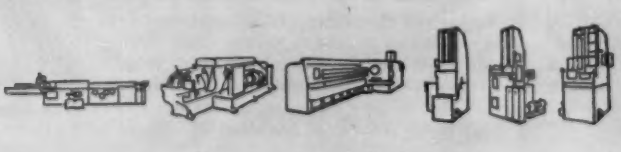
SMALL CONVERTIBLE BROACHING MACHINE

For surface and internal broaching. This combination Push and Pull type universal broaching machine is 4-ton, 24-inch stroke.

THE LAPOINTE MACHINE TOOL COMPANY

HUDSON, MASSACHUSETTS • U.S.A. *In England: Watford, Hertfordshire*

THE WORLD'S OLDEST AND LARGEST MANUFACTURERS OF BROACHING MACHINES AND BROACHES



LAPOINTE

known to be the best in BROACHING

BATH Tap'n Gage TIMES

A series of technical discussions that will be helpful in getting better results from tapping and gaging operations

Vol. 1 No. 2

Subject: Screw Thread Classes of Fit:

Screw thread classes of fit have been set up for the purpose of assuring the interchangeable manufacture of screw thread parts. These classes include 1A, 2A and 3A, applied to external threads and 1B, 2B and 3B applied to internal threads. The requirements for a screw thread fit for specific applications can be met by specifying the proper combination of classes for the components. Most requirements however will be satisfied by selecting one of the following combinations:

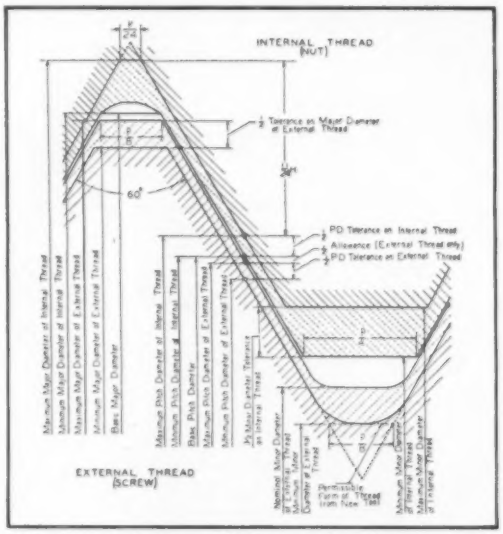


Illustration of tolerances, allowances and crest clearances for classes 1A, 2A, 1B and 2B.

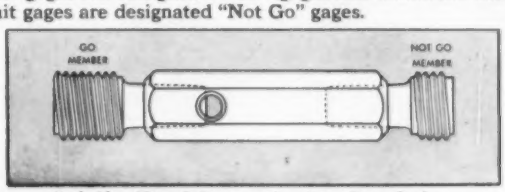
Classes 1A and 1B. These classes, 1A (external), 1B (internal) — are used on threaded components where quick and easy assembly is necessary and where a liberal allowance is required to permit ready assembly, even with slightly bruised or dirty threads.

Classes 2A and 2B. These classes, 2A (external), 2B (internal) — are designed for screws, bolts and nuts. They are also suited for a wide variety of other applications. An allowance is provided which minimizes galling and seizure encountered in assembly and use. It also accommodates to a limited extent, platings, finishes or coatings.

Classes 3A and 3B. These classes, 3A (external), 3B (internal) — are provided for those applications where closeness of fit and accuracy of lead and angle of thread are important. These threads are obtained consistently only by use of high quality production equipment, supported by a very efficient system of gaging and inspection.

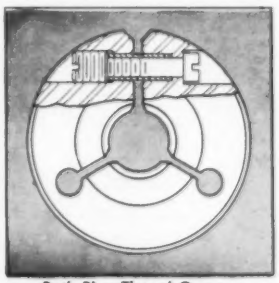
Gaging the Various Classes of Fit

Limit gages are the most effective and economical means for controlling screw thread classes of fit. Maximum metal-limit gages are designated "Go" gages and minimum metal-limit gages are designated "Not Go" gages.



Bath Plug Thread Gage — American Gage Design.

"Go" gages check or control the extent of the tolerance, as applied to a specific screw thread, in the direction of the limit of maximum material and represent the maximum limit of external threads and the minimum limit of internal threads. The ideal gage for internal threads is a "Go" plug thread gage and for external threads, a "Go" ring thread gage. "Not Go" gages control the extent of the tolerance in the direction of the limit of minimum material and represent the minimum limit of external threads and the maximum limit of internal threads. The use of "Not Go" plug thread gages and "Not Go" ring thread gages provides a satisfactory means of gaging for controlling effective size at the minimum material limits.



Bath Ring Thread Gage — American Gage Design.

More simply stated, plug and ring thread gages will satisfactorily inspect threaded components for assembly. Threaded parts will "pass" inspection if the "Go" thread plug will enter the threaded hole and the "Go" ring will thread onto the screw. At the same time, the "Not Go" plug must not enter the threaded hole and the "Not Go" ring must not thread onto the screw more than 3 turns.

Producing Screw Threads in the Popular Sizes

Internal threading is usually accomplished with taps, the pitch diameter or H Limit of which is selected according to the class of fit to be produced. Taps are available as standards in a variety of H Limits and will produce the desired class of fit when used as recommended.

External threading is accomplished with dies, thread milling cutters or other threading tools and the size of the work is governed by the adjustment of these tools.

For further reference, see U.S. Dept. of Commerce, National Bureau of Standards Handbook H28 (1957) Part I.

• Cylindrical and Thread Gages • Ground Thread Taps • Internal Micrometers John BATH & Co., Inc.
28 Mann Street, Worcester, Mass.

Use Reader Service Card, CIRCLE 34

Clouds with Silver Linings

You know that the weather has a lot to do with airplane flights, crops, and skiing. You probably have heard of making it rain by sprinkling clouds with silver iodide crystals. You also know that business "weather" has a lot to do with the orders that come in and the hours of work available.

You as tool and manufacturing engineers can be weathermakers when the business climate is not as good as it might be. Today, your company has to compete for orders not only with its neighbors but also with competitors from many nations where labor rates are one-third to one-fifth of ours.

The answer to this problem is simple to state but not always easy to carry out. The answer, which depends to a significant extent upon you, is to see that your company's unit costs are competitive with all others, even though the competitors' hourly rates may be a fraction of yours.

Carrying out the answer means that you cannot continue to do things the way you have done them for many years. You must inform your company's management of the latest materials, methods, machines and equipment that are available which can be applied to reduce your unit costs and increase the value of your products.

As an ASTME member you are informed of the latest manufacturing technology. However, valuable information that is not communicated to others or acted upon will never help your company's salesmen bring orders in or provide hours of work for your people. You can be a better business weathermaker by applying the manufacturing technology that ASTME makes available to you.

The business climate in your company depends to a large extent on your application of manufacturing technology. A rain of orders for your company depends on whether you seed the clouds with some crystals of know-how.

Dale Long

PRESIDENT
American Society of Tool and Manufacturing Engineers

Officers

H. Dale Long — President, Chicago, Ill.
William Moreland — Vice President, Ashland, Ohio
David A. Schrom — Vice President, York, Pa.
Philip R. Marsilius — Vice President, Bridgeport, Conn.
Frank F. Ford — Vice President, Atlanta, Ga.
H. Verne Loeppert — Treasurer, Chicago, Ill.
Francis J. Sehn — Secretary, Detroit, Mich.
Harry E. Conrad — Executive Secretary, Detroit, Mich.

Board of Directors

H. Dale Long Chairman Chicago, Ill.

G. Ben Berlien — Oakland, Calif.
Duane H. Brighton — Peoria, Ill.
I. H. Buck — Dallas, Tex.
Wayne Ewing — Los Angeles, Calif.
Frank F. Ford — Atlanta, Ga.
Philip R. Marsilius — Bridgeport, Conn.
William Moreland — Ashland, Ohio
W. J. Pender — Pawtucket, R.I.
Joseph L. Petz — Poughkeepsie, N.Y.
Dean F. Saurenman — Houston, Tex.
David A. Schrom — York, Pa.
Leslie C. Seager — Salt Lake City, Utah
Charles M. Smillie — Bloomfield Hills, Mich.
Albert Underwood, Jr. — Tecumseh, Ontario

Editorial Committee

John C. Hatter — Chairman, Long Island, N.Y.
William N. Moore — Vice Chairman, Riverside, Ontario
Charlton A. Brown — Vice Chairman, St. Louis, Mo.
Rayburn M. Knabe — Rock Island, Ill.
James C. Rodgers — Chicago, Ill.

Quick guide to toolroom requirements

DRILL ROD

Carbon Steel Drill Rod—A high-grade drill rod with smooth finish and extreme size accuracy.

Ry-Alloy® Drill Rod—Non-deforming . . . excellent finish, accurately sized, free from decarburization.

Ry-Alloy Ground Flat Stock—Accurately ground on all four sides. Ends and sides are square, parallel, and accurate to dimension. Free of surface decarburization . . . spheroidize-annealed for best machinability.

TOOL STEELS

Ry-Alloy Tool Steel—An oil-hardening steel. Combines high hardness and deep hardness penetration with minimum distortion, freedom from cracking. Good machinability.

V.D.® Tool Steel—An all-purpose, water-hardening carbon vanadium steel. Easy to machine . . . hard and tough after heat treatment. Hardening characteristics permit wide variation in treatment with uniformly good results.

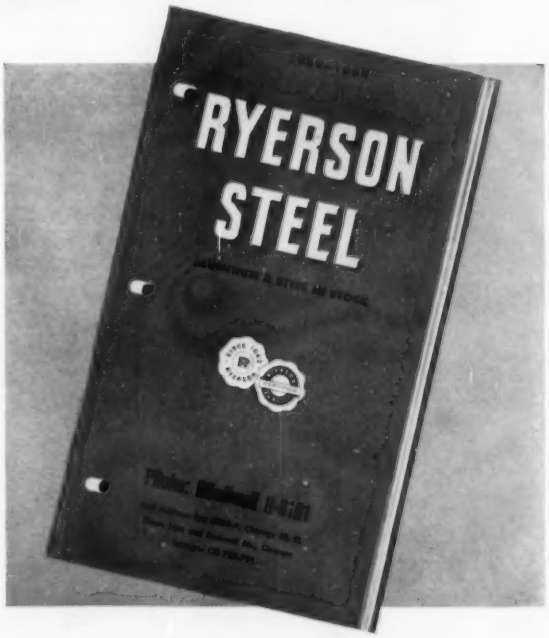
V.D. Chisel Steel—A specially developed, water-hardening carbon molybdenum tool steel ideal for hand and pneumatic chisels.

Tool Steel Sheets—Rolled from high-grade tool steel of about 1.00% carbon. Smooth, blue finish protected by oil. Can be hardened in oil or water; quenching medium depends on hardness desired. 27 gauge up to 3/16″ thick.

AISI-E 6150—For impact applications. Provides relatively high surface hardness while retaining strength and toughness throughout the cross section.

Carbon Steel Plate—All sizes and thicknesses.

E-Z-Cut® Plate—Remarkable free-machining qualities make this plate ideal for die bases, jigs, rubber molds, etc. Up to 30% savings in machining time compared to ordinary steel—with approximately 50% increase in tool life.



ALLOY STEEL PLATE

4140 Plate—An oil-hardening, annealed plate of firebox quality. Specially developed for maximum strength and uniform hardenability throughout the cross section. Thicknesses from ¼″ through 5″.

E 8615 and 8620 Plate—These oil-hardening, case-hardening alloys are ideal for flats, rings, discs and irregular shapes. Accurately flame-cut to your order.

Cold Finished Bars—A wide range of analyses. Rounds to 10″; squares to 4″; flats to 12″ x 2″.

Stripper Plate—Both surfaces ground and polished to a thickness tolerance of plus or minus .003″. Edges planed instead of sheared or rolled, insuring parallel sides free from strains. Warping and distortion after machining practically eliminated.

Aluminum Tooling Plate—Reynolds Type 33 wrought plate and Pioneer Type 921-T-DC cast plate.

Whatever your requirements, contact your Ryerson representative for widest selection, highest quality, fastest shipment, complete satisfaction.

METALOGICS

STEEL • ALUMINUM • PLASTICS • METALWORKING MACHINERY

RYERSON STEEL®

Joseph T. Ryerson & Son, Inc., Member of the INLAND Steel Family

PLANT SERVICE CENTERS: BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT • HOUSTON • INDIANAPOLIS
LOS ANGELES • MILWAUKEE • NEW YORK • PHILADELPHIA • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SPOKANE • WALLINGFORD

MESONS MAGNETS and MANUFACTURING

. . . tooling up for nuclear research

By T. W. Black
Senior Associate Editor

A team of nuclear physicists and manufacturing engineers is building a new tool for probing the unknown heart of the atom. This tool—a proton accelerator—may help to solve some of the most puzzling mysteries of science.

IN A FORMIDABLE-LOOKING round building just outside of Princeton, N. J., a team of scientists and engineers is putting the finishing touches on what may become an important weapon in mankind's continuous assault on the unknown.

The building, partially covered with earth, resembles a military gun emplacement or pillbox, *Fig.* 1, and this resemblance is more than coincidental. For what the building contains is a gun—a gun capable of firing bullets with velocities that approach the speed of light.

The bullets are protons and the gun is called a proton synchrotron. It is being built by Princeton University and the University of Pennsylvania under Atomic Energy Commission sponsorship. With it, scientists hope to find answers to one of the most puzzling questions of modern physics: what is the atomic nucleus made out of?

In the synchrotron, a beam of protons passes around the periphery of a huge ring magnet, *Fig.* 2. Between several of the magnet sections are radio-frequency accelerators that give the protons in the beam a "kick" each time they pass around the ring. The beam is focused by the magnetic field, which increases automatically to compensate for the tendency of the protons to fly out of the ring as their velocity is increased.

This acceleration is extremely rapid. During 1/40th of a second the protons travel 4000 miles and their final speed approaches the speed of light. When full speed is attained, the beam is deflected into a platinum target and many of the protons penetrate to the atomic nuclei, causing some of them to disintegrate into a shower of particles —π mesons, μ mesons, hyperons, neutrinos and others. Some of these particles immediately decay —hyperons have a half-life of 10^{-10} seconds, for example, before they decay into protons and neutrons—others form secondary beams that are used in further experiments.

The events that take place when protons smash into atomic nuclei are not well understood. There are not enough facts to develop a workable theory at present but synchroton experiments may provide the sort of conclusive data on which tenable theories can be based.

Several other powerful synchrotrons are in operation in this country and abroad. Where most proton

Fig. 1. Synchrotron magnet during assembly. Yoke blocks are arranged in sequence on carefully leveled weldments. When all blocks are in position, the coils, seen at right against the wall, will be installed.

Fig. 2. (below) Plan view of synchrotron. Protrons are accelerated from rest by the Van de Graaff machine and pass down tube to enter magnet ring. As they travel around the ring in a clockwise direction, they are accelerated by four radio-frequency (RF) stations. Personnel are protected from lethal radiation by a 15-foot-thick high-density concrete wall.

synchrotrons operate at one pulse every five seconds, the Princeton-Pennsylvania machine operates at 20 pulses per second—one hundred times faster. Thus it fires more proton bullets, makes more hits and produces more subnuclear particles than other synchrotrons during an equal period of time. This should materially shorten the time required for many individual experiments.

Will the synchrotron work? Scientists and engineers assigned to the project are sure that it will. Working scale models of magnet sections and other major components have performed as their designers intended. But there is often a big difference between the performance of a prototype and the actual performance of the real thing, built under production conditions.

So, in the end, the responsibility for the success of the synchrotron rests solidly on the shoulders of the manufacturing engineers and production men who translate blueprints into reality.

Process Control: Although most of the synchrotron components are manufactured by standard processes, the degree to which these processes

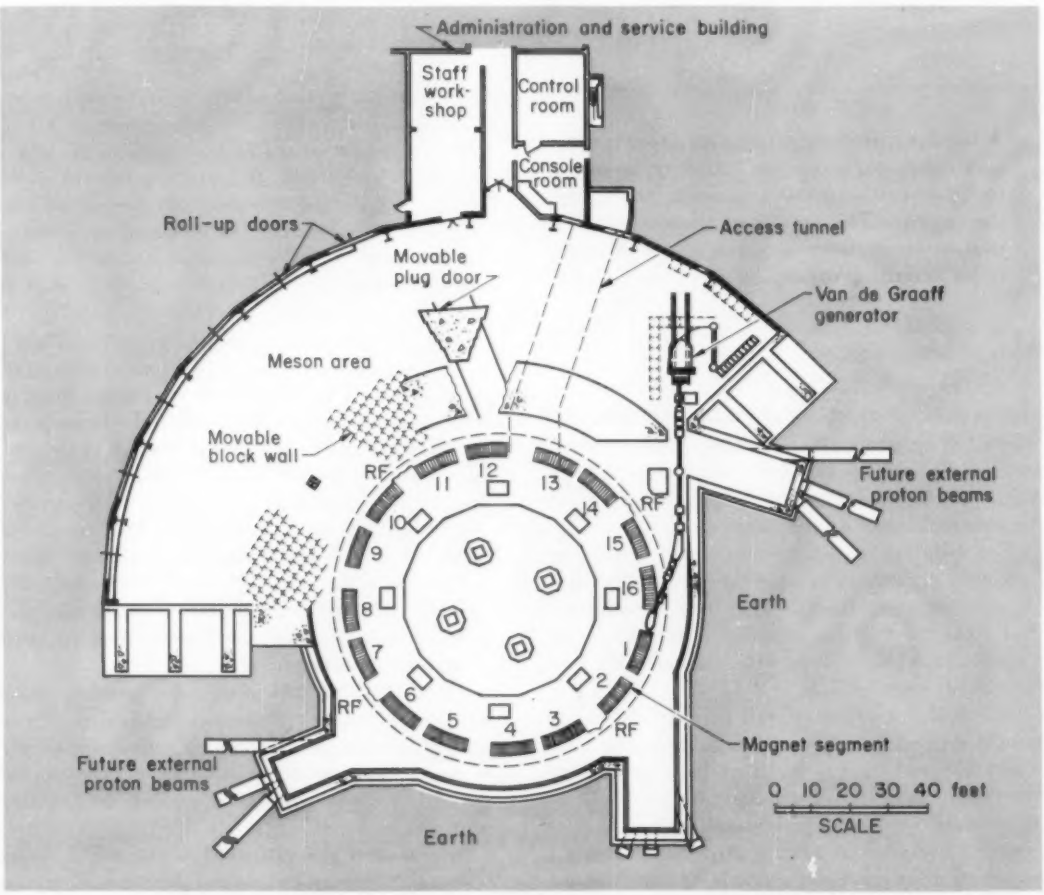
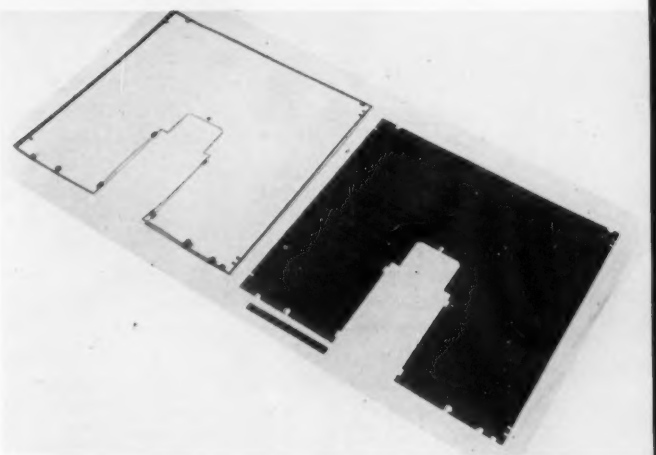


Fig. 3. (left) Individual yoke block being inspected after final assembly. Gap height, being checked here, is a critical dimension.

Fig. 4. (below) Yoke block lamination after final punching operation (right). Trimming is shown at left.



are controlled is almost unprecedented. This close control is necessary to insure that the completed synchrotron will operate successfully. Unless all magnet sections are identical, for example, the beam of protons will not be correctly focused during acceleration. When the size of the magnet ring is considered, the magnitude of the manufacturing control problem becomes apparent.

The ring is divided into 16 semi-octants, with 47 yoke blocks in each semi-octant. Each yoke block, *Fig.* 3, is assembled from 120 individual laminations, so the entire ring contains over 90,000 laminations. These laminations must be identical within ± 0.002 inch at 97 separate check points. The magnet has detachable upper and lower pole blocks that are also assembled from individual laminations. These laminations must be identical within ± 0.0001 inch at some points.

Laminations in both the yoke and pole blocks are bonded together with an adhesive. The thickness of the adhesive on the side of each lamination must be no greater than 0.0005-0.0006 inch in order to maintain the correct density of metal throughout the ring. After bonding, the sides of each block are machined so that the completed block, seen from the top of the ring, is tapered, making it possible to fit the blocks tightly, side by side, into the ring. Tolerances for this machining operation are tight.

Shuffled Steel: Control of the operating characteristics of the completed blank started at Armco Steel Corp. The steel used for laminations was specially rolled into 37-inch-wide strips, 0.025 inch thick. A 3.75 percent silicon content was maintained. To insure uniform chemical, electromagnetic and mechanical characteristics, the steel was rolled from material made in successive heats and rolled in consecutive mill runs. After pickling, the steel was coated with Carlite, an inorganic insulating material, and cut into 36½ x 38½-inch blanks.

Fig. 5. Yoke lamination inspection fixture. Operator is checking parallelism of gap edge with base of lamination, using a reference plate.

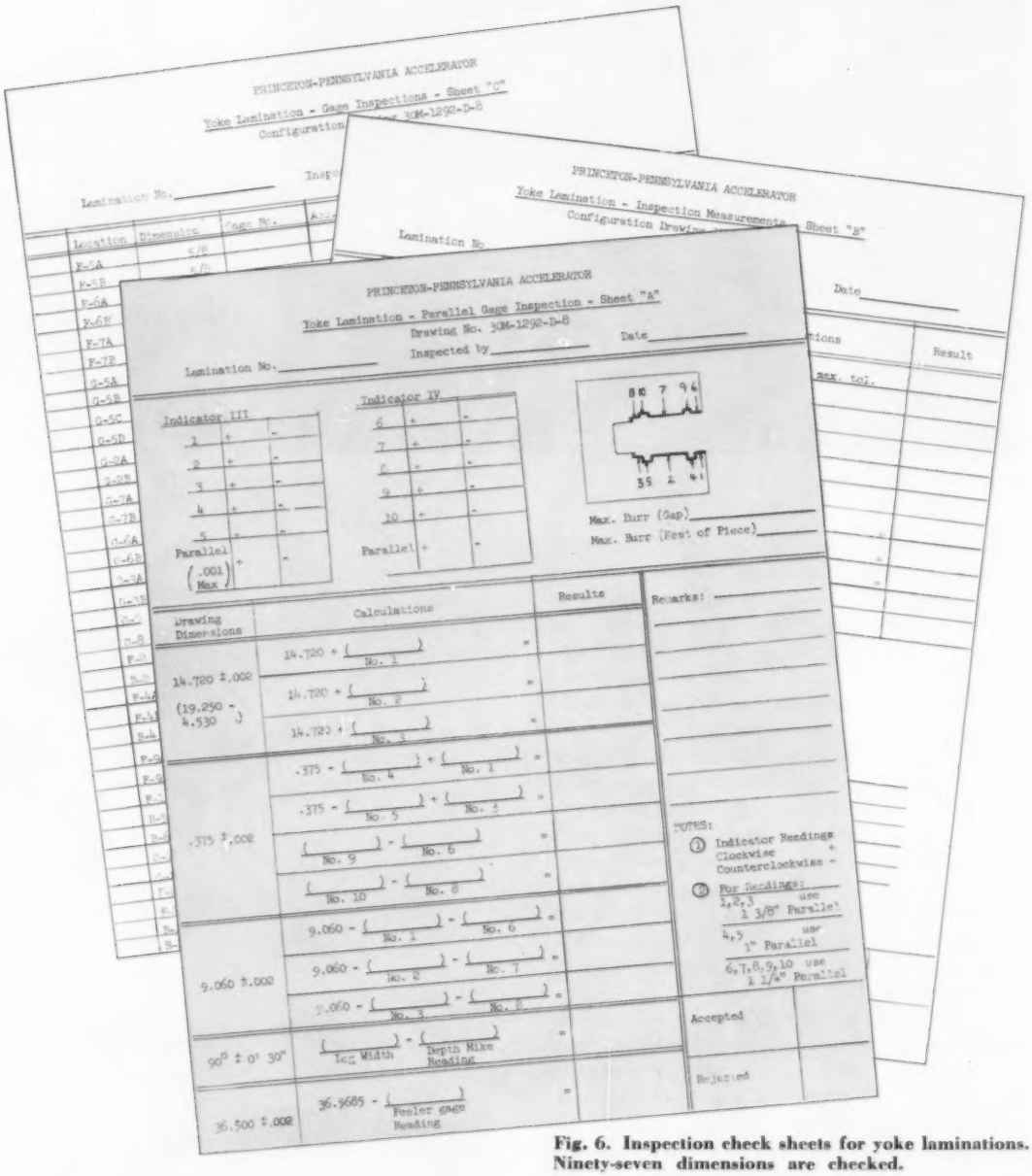


Fig. 6. Inspection check sheets for yoke laminations. Ninety-seven dimensions are checked.

When the blanks were placed on skids for shipment, the order in which the blanks were produced —essentially the order in which the material was rolled—was preserved, with those produced earliest on the bottom of the skid. There were 145 skids of blanks, each weighing approximately 7500 lb. Each skid was numbered to identify the heat from which the steel was produced and the order of the steel within the heat. The direction of feed from the rolling mill was also marked on the skid. These skids were shipped to Cleveland Tool and Die Co., Cleveland, Ohio, where the laminations were punched.

Prior to punching, however, the blanks were shuffled according to a planned statistical program. The purpose of shuffling was to distribute all cyclic variations in magnetic properties uniformly throughout the material and to equalize sheet thickness variations. The shuffled sequence of sheets is maintained through all subsequent operations.

Punching: Punching the yoke and pole piece laminations is regarded as a difficult operation. The electrical steel is brittle: in fact pieces of the sheet can be broken off with the fingers. Care in handling

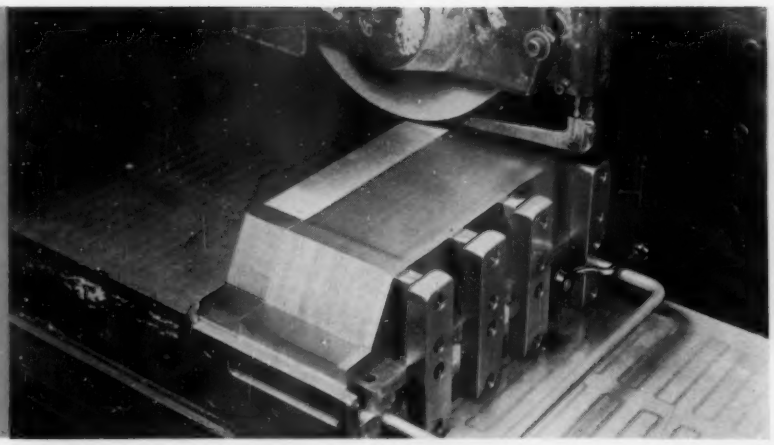


Fig. 7. Grinding fixture for straight pole tip laminations. About 160 laminations are ground simultaneously.

is necessary, since specifications state that the Carlite coating is not to be broken. Since burrs could cause magnetic shorting of the laminations in an assembled yoke block, with consequent eddy current losses, burr height cannot exceed 0.001 inch in certain critical areas or 0.002 inch anywhere.

Two punching operations are required on the yoke laminations: first, a prenotching operation that removes material from the open area of the "C" and second, a final punching operation to attain correct size, *Fig.* 4. The outfall from the gap is kept in shuffled sequence and is the raw material for the pole tip laminations.

Specifications require that all laminations punched meet the predetermined design size and that any yoke lamination produced be within 0.002 inch of any other yoke lamination. This usually implies expensive dies, but production requirements were analyzed in terms of task performance versus cost and calculations made. By careful die design and construction, the lamination accuracy requirements were met at a reasonable cost. Die construction also included provision for continuing accuracy of production with a minimum of die maintenance work. Supplemented by trend control, the die design assured production of the laminations within the set tolerances.

All punching is done on a 300-ton hydraulic press. Tool steel is used as a die material. This has given satisfactory performance throughout the production run. Punch-die clearances are extremely small (0.0015 inch). This small clearance is necessary to control the squareness of the edge of the lamination. With greater clearances, the material tends to bend and is therefore sheared at an angle. The final punching die is designed with four separate corner sections, connected by long rails to trim the sides of the lamination. The tendency of the corners of the lamination to break off during punching or handling has been overcome by providing a 0.040-inch radius on all corners. Strippers have square heads to hold the material securely during punching and they are resharpened frequently to maintain sharp corners. The die itself is reground after 20,000 pieces are run.

Controlling Trends: Despite the many variables that affect precision punching operations, all laminations produced have been within size tolerances. This has been due to the fact that size trends are continuously monitored and corrective action is taken long before out-of-tolerance laminations are produced.

Inspection is on a sampling basis. At least one lamination out of each group of 240 is completely inspected on a special fixture, *Fig.* 5. The lamination being checked is sandwiched between spring-loaded aluminum plates to prevent ripple. Dial gages,

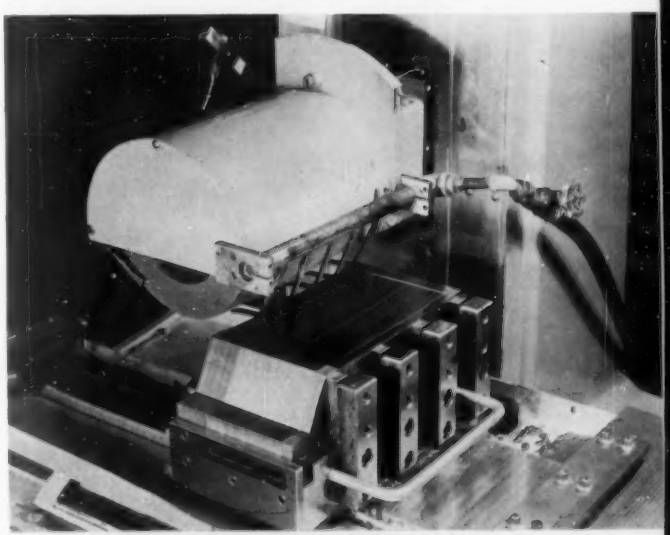
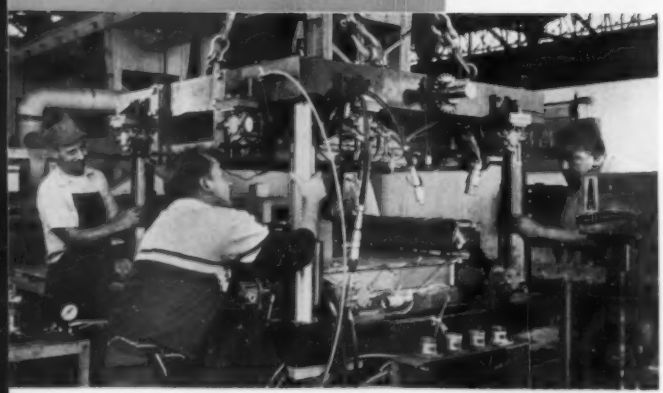


Fig. 8. Pole tips with curved edge are ground with an especially dressed long wheel. The wheel is dressed with a contouring attachment.

Fig. 9. (right) Adhesive is applied to yoke laminations by roller. After the sheets are coated, they pass directly into a drying oven.

Fig. 10. (below) Curing fixture for yoke blocks consists of two die halves that are individually loaded.



reading to 0.0001 inch, Go Not-Go gages and other inspection devices are held in a heavy plate at the top of the fixture. Guide pins insure alignment of the lamination in the fixture.

The parallelism of the edges of the gap with the base of the lamination is particularly important, since any out-of-parallel condition could interfere with the proper alignment of components when the magnet ring is assembled. Parallelism is checked with the aid of a basic reference plate that contacts the two corners of the lamination base. Two arms on the reference plate project through the fixture, contacting the top and bottom edges of the gap for parallelism and gap height measurements.

While this fixture appears complicated, it is designed for easy use and for minimum dependence on operator judgment when setting up for inspection and taking readings. These readings are recorded on special check sheets, *Fig.* 6, which show the readings taken, any necessary calculations, gage numbers and other pertinent information. The readings are also plotted to make trends visible.

The need for die sharpening is usually apparent from charted dimensional trends. The most important short-range variable is die temperature. After a die sharpening, for example, the die is not used for production until it has become thermally stable. The die is also protected against wide variations in ambient temperature.

Though die maintenance minimizes burrs, they are critical. Deburring is simpler than inspecting, so each lamination is carefully deburred by hand, using an abrasive stone. Since there are about 15 linear feet of edge to be deburred on each lamination, the total length to be deburred during the course of a production run of some 100,000 laminations is nearly 300 miles.

Deburring completes the operations on the yoke laminations, which are shipped to Baldwin-Lima-Hamilton Corporation's Industrial Equipment Div. near Philadelphia for bonding and taper machining. The shuffled sequence is maintained when the laminations are packaged for shipping, as is the division into 240-sheet stacks. All stacks are clearly identified so that control over the shuffled sequence can be maintained through subsequent operations.

Pole Tips: Pole tip laminations are of two basic configurations. Both configurations are punched on a mechanical press and the over-all requirement that they be identical with each other within ± 0.002 inch applies. However, some of the tolerances are so small that they cannot be held in punching; thus grinding operations are required. Pole tips of the configuration shown in the drawing are ground, 160 at a time, in a fixture that holds them tightly to eliminate ripples, *Fig.* 7. In an initial series of operations, three short edges are ground. Then the fixture is shimmed at one end for grinding the 11.326-inch-long taper on the top of the pole piece. A silicon carbide wheel is used.

On pole tips of the second configuration, the long

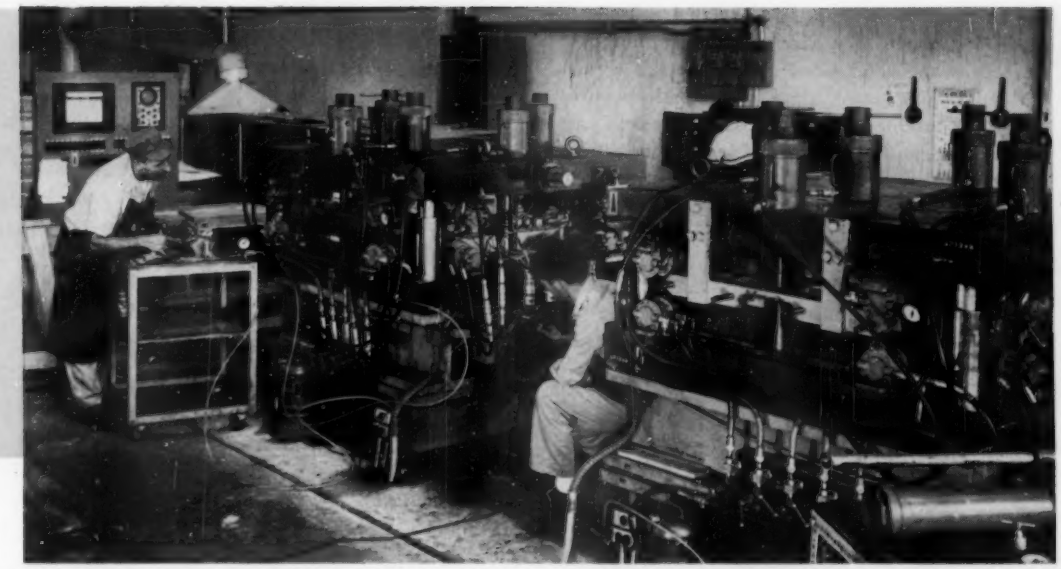


Fig. 11. Curing fixtures ready for start of curing cycle. Hydraulic jacks maintain pressure during the cycle. Controls for the hydraulic jacks are mounted on the table in front of the operator. Electrical control panel to rear of operator has a strip chart for recording temperatures during curing.

edge is slightly curved. A 9.420-inch-long resinoid-bonded silicon carbide wheel is used to generate this curve, *Fig.* 8. The wheel is dressed to the proper contour with the aid of a curved template and a special dressing fixture. With the curved wheel, the curve is ground in one fast operation and the need for what could have been a rather elaborate contour grinding arrangement is eliminated.

Still in the grinding fixture, the pole tip laminations are transferred to an inspection area after grinding. With the addition of an inspection plate, the grinding fixture becomes an inspection fixture. In general, the same inspection procedures as used for the yoke laminations are followed.

Bonding: Cementing the individual laminations into 120-sheet blocks is perhaps the trickiest operation in the manufacture of the synchrotron magnet. Pole tip blocks are bonded at Princeton, using thin sheets of precured cement and eddy-current heating. Bonding of the yoke blocks is performed at Baldwin-Lima-Hamilton.

The key to success in the bonding operations has been close process control. At Baldwin-Lima-Hamilton, the yoke laminations are received on skids containing 720 laminations. The laminations are removed from the skids individually and hung on racks for vapor degreasing. After degreasing, the laminations are stacked in blocks of 120. The blocks of laminations are three inches thick—a convenient size for handling and heating.

A white, powdery oxide remains on the laminations after degreasing. The first 10 sheets on the

Fig. 12. Yoke blocks are planed to produce taper. Wood-grain effect on the blocks is actually the edges of individual laminations.

top and bottom of the block are individually hand cleaned to remove this oxide, which might affect the strength of the bond. Good bonding in this area is particularly important, since parts of the laminations are machined away when the blocks are tapered. Unless the bond is strong, the laminations tend to peel off or curl during machining.

Immediately after cleaning the laminations are fed, one at a time, into a roller coating fixture that applies adhesive, *Fig.* 9. The use of precured sheet adhesive would make it easier to control adhesive thickness; however, sheet adhesive of the required size was not available at the time the production run on the yoke laminations started. Both sides of each lamination are coated with adhesive in the fixture, then the laminations are carried through a 50-foot-long drying oven at a speed of 25 fpm for drying. The oven temperature is 300 F.

Fig. 13. Belt sanding operation on yoke blocks. With planing tools removed, the belts are lowered into position for final finishing of the surface.

As laminations emerge from the drying oven, they are stacked in a curing fixture, *Fig.* 10. At this time they are still in the sequence established by shuffling at Cleveland Tool and Die. The fixture consists of two die halves, each of which contains 120 laminations. The upper die half is mounted on a trunnion fixture and is loaded in the upside-down position, then rotated into the upright position after the sheets are loaded and bolted down. A crane picks up the upper half and lowers it into alignment with the lower die half. Coils are then placed around the blocks, which are heated by induced eddy currents, *Fig.* 11. The advantage of this heating method is that all laminations in the block are heated quickly and uniformly. With furnace heating, a long time might be required to heat areas in the center of the block.

About 250-psi pressure is applied during the curing cycle, which takes approximately three hours at 375 F. Heating is controlled so that temperature differentials do not exceed ±25 F. Thermocouples at several strategic locations monitor temperatures, which are recorded on a strip chart. After curing, the 120-sheet, 1000-lb solid blocks are allowed to cool in the fixture for about eight hours. All blocks are numbered to retain the correct sequence.

When the blocks are removed from the fixture, they are cleaned to remove extruded glue and preliminary dimensional and electrical resistance checks are made. Thickness of the adhesive coatings is checked by comparing the weight of the blocks before and after bonding. These weights are carefully watched to insure control of trends.

Taper Machining: Both sides of each yoke block are taper machined so that the blocks will fit tightly into the ring. Twelve blocks are machined at one time on an eight-foot planer, *Fig.* 12. After planing, belt grinders, mounted directly on the rail of the planer, *Fig.* 13, improve the surface finish of the blocks. By installing the belt grinding attachments directly on the planer, Baldwin-Lima-Hamilton eliminated the need for removing the blocks to another location for a separate machining operation.

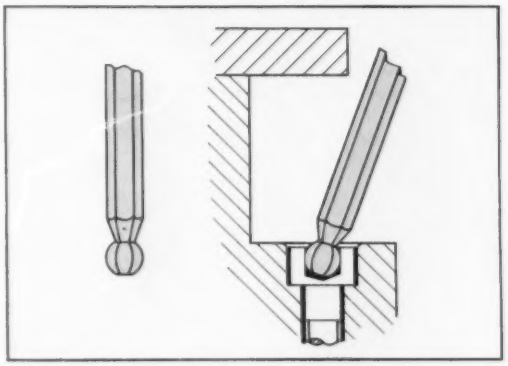
After machining, all surfaces of the blocks that require inspection are thoroughly cleaned with solvent and the machined dimensions are inspected. Then cooling coils are assembled to the top and bottom of each block and ceramic feet are assembled to the bottom, using an epoxy cement.

Final Assembly: At Princeton, the yoke blocks are positioned in the synchrotron magnet ring as they are received from Baldwin-Lima-Hamilton. They are set in place according to the curing sequence, by quadrants. Thus the first block received is placed in the number one position on the first quadrant, the second block received is placed in the number one position on the second quadrant and so on. Asbestos spacers are placed between the blocks. Once all of the yoke blocks in a magnet section are in position (shims are used if necessary to obtain correct alignment), the magnet coils are installed, then the pole blocks and finally the vacuum chamber.

Some time in mid-1961 a scientist in a remote-control room will push a button that sends protons racing around the main magnet ring for the first time—a controlled beam of protons made possible by controlled manufacturing processes and by close cooperation of scientists and engineers.

Gadgets

Ingenious Devices And Ideas



Wrench Tightens Hard-to-Get-at Screws

Socket-head wrenches modified as shown are useful for turning screws in otherwise inaccessible locations. Because line contact only, instead of full surface contact, is provided, final tightening must be accomplished with a conventional wrench.

A. E. Conley
Coventry, England

Cutoff and Groove-Rolling Die

Axle shafts and other similar parts which must have grooves for retaining rings can be processed quickly in the die illustrated. The drawing shows the die in the up position. The stock, in the form of a rod, feeds from the left through a hole in a cutoff block and passes through a slotted block attached to the punch holder. These blocks are fitted with hardened inserts which perform the cutting operation. The cut piece is pushed to the right as the stock is fed in and stopped against a screw. On the next stroke the cut piece resting on a shelf is rolled downward between two rolling blocks. The block attached to the die has ridges which roll the groove into the workpiece. At the bottom of the stroke the part rolls off the shelf and through a hole in the die.

Ernest Jones
Bronx, N. Y.

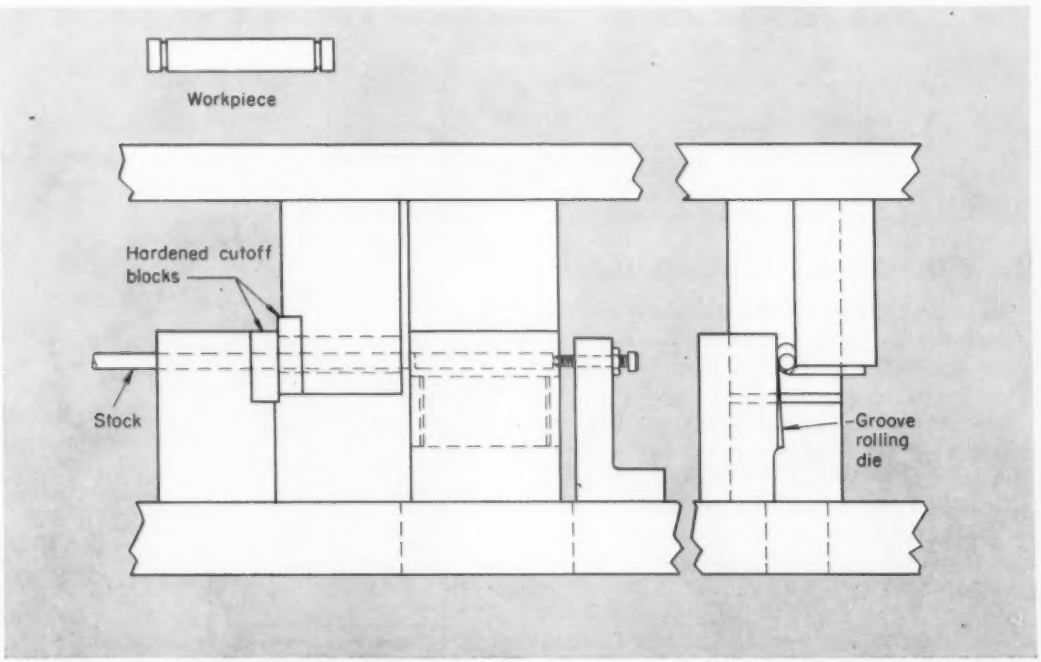


Plate Increases Gage Accuracy

To be used effectively, center gages must be held parallel to, and flush with, the cutting tool face. This condition is easily established with the pedestal type gage holder illustrated. In this device, tool and gage surfaces are placed in a common plane by a transparent plastic plate. The gage is secured to the underside of the plate with screws and the tool is positioned manually.

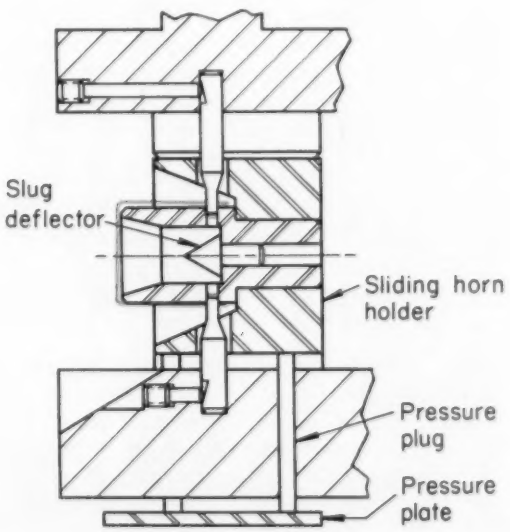
H. J. Gerber, Member-at-Large

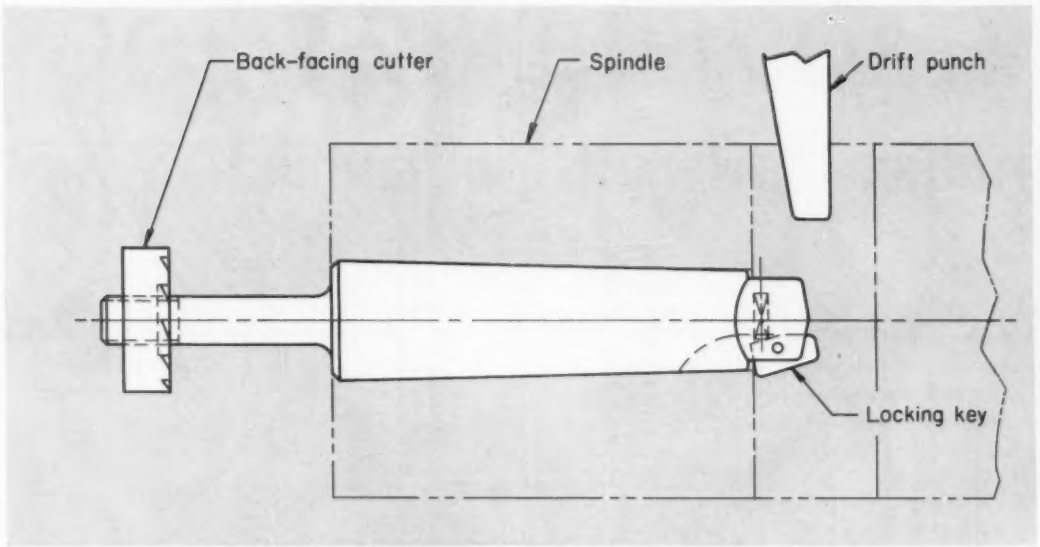
Horn Die Pierces Opposed Holes

Diametrically opposed holes are usually pierced in cam dies. In the die illustrated this operation is accomplished with a sliding horn actuated by air or spring pressure.

First step in the sequence occurs at initial die closure when the upper punch pierces the shell. Continuing die closure forces the sliding-horn holder to descend until a stationary punch in the lower die pierces the second hole. Punch and die alignment is insured by mounting the horn holder on guide pins.

Frank Murray
Detroit, Mich.





Key Holds Cutting Tool During Backfacing

Backfacing—the machining of inside bosses—is generally complicated by loosening of the cutter shank within the machine spindle. The shank design illustrated eliminates this problem by means of a locking key which engages the drift-punch opening.

When machining has been completed, the cutting tool is driven from the spindle with a conventional drift punch. However, before pressure is exerted, a corner of the punch disengages the locking key from the opening. Continuing advance of the punch then forces the cutting tool shank from the spindle.

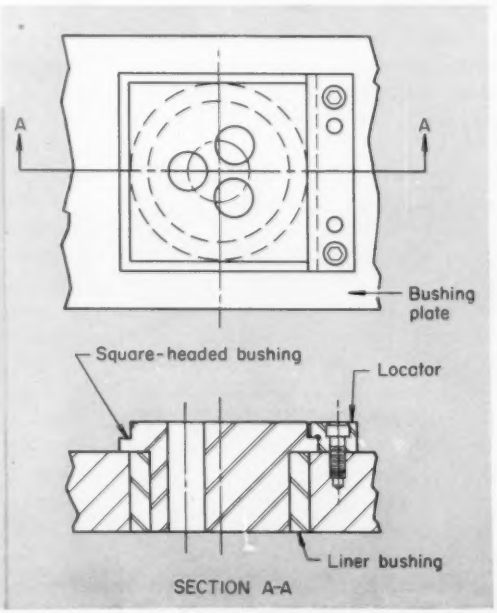
Wendall T. Ingham
Springfield, Mass. Chapter

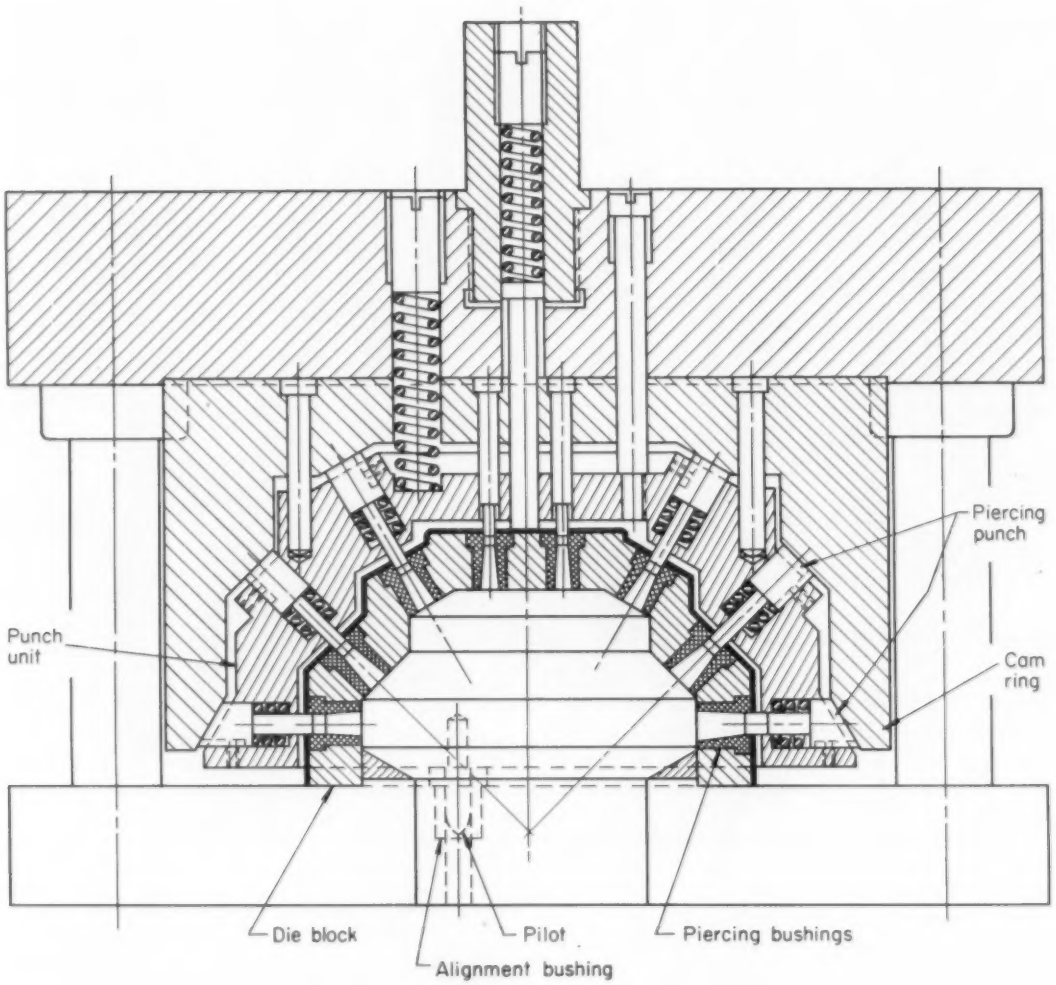
Index Fixture Drills Different Parts

Similar parts occasionally have hole patterns which are identical but at different coordinate positions. One solution to the tooling problems incurred by these designs is an indexing drill bushing through which all holes are drilled.

In the fixture illustrated a three-hole pattern can be drilled in four different positions. This is accomplished by a round bushing with a square head which is held in position by a hardened and ground locator. Upon completion of one production run, the bushing is easily indexed and reset at the next position.

Roger Isetts
Kenosha, Wis.





Cam Die Pierces Multiple Holes

Twenty-six holes located radially at four different angles are pierced simultaneously in the cam die illustrated. Unlike conventional cam dies, this tool retains all its punches in a single movable unit. Upon activation, this unit, guided by leader pins, advances ahead of the die until it arrives in piercing position. Continuing die closure causes the cam ring to contact the punches, forcing them through the workpiece.

Stripping, a critical factor in this die, is effected by heavy spring pressure under the punch heads. This pressure must be 100 percent effective since any unstripped punch will be broken as the dies open.

Hjalmar Dahl
Upplands Vasby, Sweden

Contributions for these pages describing short cuts for the tool engineer are welcome. Finished drawings are not necessary. Honorariums for accepted articles are sent upon publication.

how to cut
TOOL AND DIE COSTS
Part 3—Eliminating Heat-Treat Failure

By J. S. Pendleton, Jr.*
Metallurgist
The Carpenter Steel Co.
Reading, Pa.

Faulty toolmaking and design practices are responsible for much of the part damage and destruction incurred during hardening. This article explains how all departments—design, toolmaking and heat-treat—can reduce tooling costs by eliminating heat-treat failures.

TOOL AND MANUFACTURING ENGINEERS who are concerned with cost-reduction in their tooling programs must sooner or later evaluate the losses attributed to their heat-treat departments. Such evaluations are important since heat-treat departments in many plants are held accountable for any and all cracked or fractured die sections. Ironically, a sizable percentage of the so-called heat-treat failures can be rightfully attributed to toolmaking and tool-design departments—the people who are foremost in indicting "heat-treat" when failures occur.

There are, of course, hardening procedures which result in tool failure or destruction as shown in *Fig.* 1. However, any realistic cost-reduction program must identify all sources of tool failure and establish practices leading to their elimination.

Steel Selection and Tool Design: Evidence of what can happen in heat-treating when designers and toolmakers fail to follow certain fundamental rules is illustrated in *Fig.* 2. This is a component of a combination notching and bending die. Made of water-hardening tool steel, it failed in heat-treat simply because its screw holes were placed too close to the edges. If hole locations in sections such as this are critical, the part should be made of oil-hardening or air-hardening steel. Assuming that hole locations are not critical, water-hardening steel is satisfactory provided the holes are moved in from the edge. A basic rule to follow is that safety from quenching cracks must be designed into the tool or built into the steel. In short, tool-steel selection should not be based on tool function alone: it must also be based on heat-treat characteristics.

Designs which permit uniform heating and cooling are the best safeguard against cracking and breakage. When a piece is quenched, extreme differences in temperature between any two points are a source of internal stress and the closer these points are together, the greater are the internal stresses. Designs containing these hazards can often be modified—sometimes only slightly—to greatly lessen the chance of heat-treat failure. Large investments in tools and dies can be protected simply by using generous fillets and drilled holes which balance the heating and cooling rates of various sections.

Occasionally a combination of variables will result in tool failure as shown in *Fig.* 3. In this example holes are placed close—but not dangerously close—to one edge. With proper handling this section could have been hardened but the heat-treat operator was relatively inexperienced. Later it was found that hole positions were not critical: they might easily have been moved in to a safer area. Thus the failure of this section can be attributed to poor handling and faulty planning.

Annealing Before Hardening: In many cases annealing for stress relief is performed only on the more difficult sections. If this policy is extended to all tool and die components, it will generally pay dividends by minimizing tool failure during heat-

*Senior member ASTME Schuylkill Valley chapter.

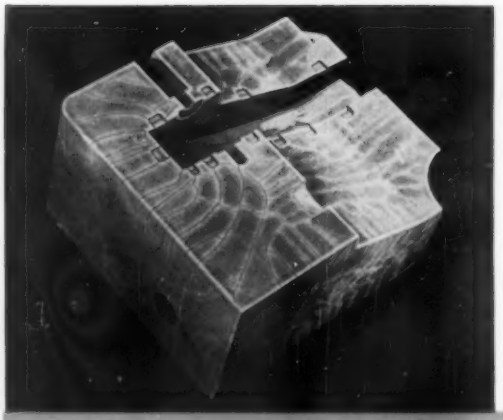


Fig. 1. Complex die section ruined by excessive carburization. Failures such as this occur when faulty hardening techniques are used.

Fig. 2. Tool failure resulting from faulty design and poor selection of steel. Fractures are caused by close proximity of holes to edges.

treatment. As an example, the section illustrated in *Fig.* 4 fractured in quenching, the crack originating in a stamp mark on the large diameter. Deep stamp marks create internal strains and provide a place for cracks to start. Even prick-punch marks used in die layout can cause cracks of this type. Light stamping is beneficial in eliminating such failures, but the best way to eliminate them is to stress relieve the piece by annealing. Stress relieving by annealing is also necessary when (a) die sections are to be subjected to stress from cold hobbing, bending, forming and coining operations; and (b) large amounts of metal are removed in machining. The latter is especially important if the material used is water-hardening or oil-hardening tool steel.

For extreme accuracy, it is best to rough machine, anneal and then finish machine with a light cut. Stress-relief annealing is accomplished by heating the piece to a point just below the critical temperature followed by furnace cooling. Cooling in lime or dry ashes is also acceptable.

Although annealing is effective in eliminating stress caused by surface marks or insufficient bark removal, it should not be used in an attempt to correct both deficiencies simultaneously. Occasionally such attempts are successful but in the long run the economies they provide are generally outweighed by the failures they cause.

Heat-Treat Failure: The number of ways in which actual heat-treat failure occurs is limited. When it does occur, a thorough investigation of the part and the heat-treating procedure used should be made to avoid similar failures in the future. A fundamental rule of such investigations is that the tool should not be annealed for hot-acid inspection until all possible inspections in the hardened state have been made. This is necessary because annealing can destroy a great deal of valuable information which might not be disclosed by acid. If possible, the tool should be broken in two to provide two test parts—one for acid and the other for hard inspection.

Predominant among the causes of heat-treat failure are cracks resulting from excessive carburization or decarburization. Flash or uneven heating can also ruin a tool. Flash heating was the cause of cracking in the tool shown in *Fig.* 3. Uneven heating can be the source for decarburization as shown in *Fig.* 5.

Elimination of excessive carburization and decarburization is the best possible insurance against cracks. As shown by the component in *Fig.* 1, too much carbon absorbed from the usual carburizing mediums can be disastrous. Made of 5 percent chrome hot-work steel, this die section should have been carburized in a lean atmosphere or dilute compound. Instead it was surrounded with an energized

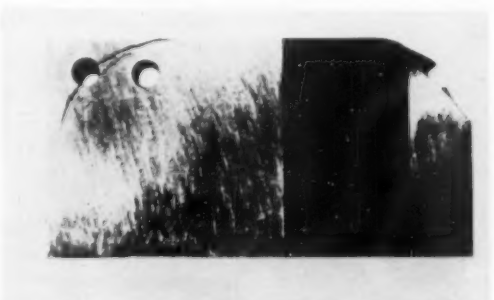


Fig. 3. A result of flash heating. Poor designing and careless heat-treat combined to cause this fracture.

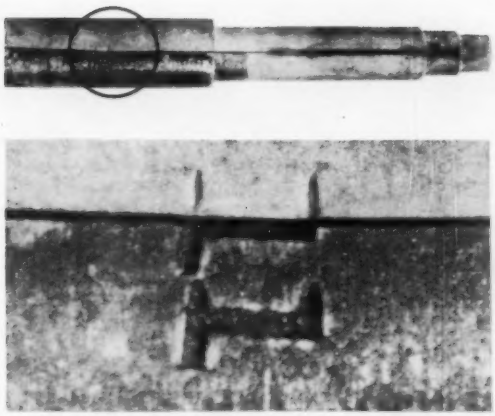


Fig. 4. (above) Failure resulting from stamp mark. Stresses built up around indentation cause fracture during quenching.

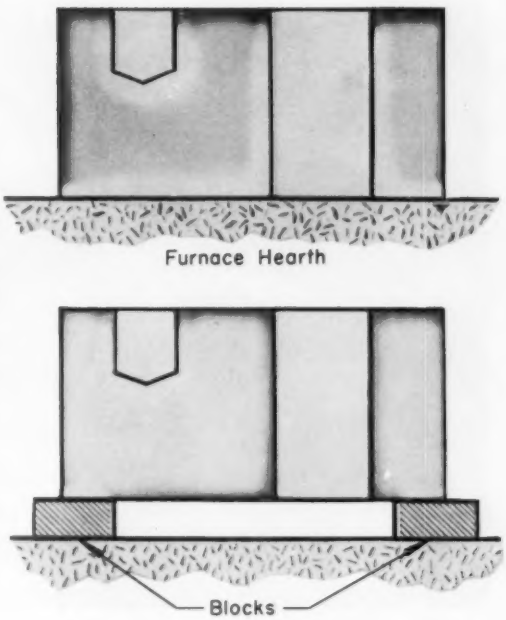


Fig. 5. (right) Decarburization resulting from improper positioning during heat-treat. Adequate circulation of furnace atmosphere is necessary to prevent this condition in tool-steel components.

compound which allowed absorbtion of an excessive amount of carbon. As a result numerous cracks appeared on the surface after quenching and a valuable part was ruined.

Soft spots in steel, particularly those which appear on cutting edges, are another important source of tool failure. Normally they appear most often in the water-hardening steels. Their occurrence in even relatively unimportant surfaces can cause sizable strains to develop. The added strain of grinding may be enough to produce a crack separating the soft spot from the surrounding metal.

Soft spots are usually formed by steam or gaseous interference with the normal quenching action. In fresh water, steam forms on the surface of the hot metal and this, combined with dissolved gases released from the water, acts an an insulating film on the work surfaces, preventing uniform hardening, particularly in holes and recesses. Holes and recesses are most susceptible since they act as pockets which trap the steam and gas. However, this difficulty can be eliminated by quenching in a 5 to 10 percent brine solution.

A third important cause of tool failure is warpage. This can result from incorrect part positioning in the furnace and faulty quenching techniques. If long thin tools are placed horizontally on an uneven hearth, they tend to sag while hot and soft. It is good practice either to level off the furnace bottom with sand or to suspend the tools vertically in a vertical furnace. Warpage can also occur when tools or dies are blocked up to insure proper circulation of atmosphere. The solution here is to space the supports close enough to eliminate sagging without interfering with furnace circulation.

Proper immersion of the tool in the quenching medium is another precaution against warpage. As a tool is lowered horizontally into a quenching tank, the portion which enters the bath first contracts fastest. This causes a hot-upsetting condition in the upper portion of the tool. As immersion continues the upper edge will also contract. However, because of hot-upsetting this part is now dimensionally longer than the remainder of the piece and warpage results. This type of warpage can be prevented if all long, slender tools are quenched vertically rather than horizontally or at an angle.

Still another cause of tool failure—particularly in finished sections—is size change. Some size change is to be expected in the water-hardening and oil-hardening steels. However, if the size changes are greater than expected, the hardening temperature may have gotten out of control. Generally an oil-hardening tool steel will come out close to original size provided it has been annealed for stress relief, and hardened and drawn at correct temperatures. Either overheating or underheating will cause significant changes in oil-hardening steel. High-carbon, high-chromium steels will shrink badly when overheated.

When dimensional stability is critical it is always good policy to use air-hardening tool steel. This is especially true in tool and die components which cannot be finish ground. Good examples of such parts are thread-rolling dies, cavity sections and punches with complex configurations. Because heat-treat distortion cannot be corrected in these components, material stability throughout the heat-treating process is imperative.

Fig. 1. Thompson-Ramo-Wooldridge continuous-path control system drives a retrofitted HydroTel equipped with an added fourth rotary axis. The control system uses binary-coded-decimal tape input and can be programmed without using a computer.

Contours Without Computers

. . . breakthrough in numerical control

By Robert Heslen, Associate Editor

Tapes for contour machining can be developed without a computer, using a new system that employs a simplied tape format and special computational aids. This breakthrough may lead to wider use of numerical control.

NUMERICAL CONTROL has demonstrated its ability to cut the cost of machining contoured parts. Many companies have found that this cost advantage is at least partially offset by the need for a computer to produce machining programs. While it is possible to rent computer time and services, companies with short lead-time requirements prefer to avoid the risk of delays that can occur when "outside" computers are loaded with other work.

To overcome these problems, engineers at Thompson-Ramo-Wooldridge Corp. have been working for several years to develop a control system that can be programmed without a computer. Although this task might appear difficult, TRW engineers felt that hand programming was feasible. For example, the straight-line movements that define much of the machining done are relatively easy to calculate by manual methods, as is done for positioning systems. Feed-rate calculations can be accomplished with nomograms. Curves and arcs are more difficult to handle, since they must be broken down into a series of short straight-line paths, because the system does not "think" in circles, but thinks instead, in straight-line slopes. (An option now available enables the system to accept conventional circle data and to generate circles.) For the slope-generating system, TRW programmers developed "incrementing tables" for defining circle approximation paths. This programming method is used with the slope-generating control system shown in *Fig.* 1.

The system accepts a binary-coded-decimal

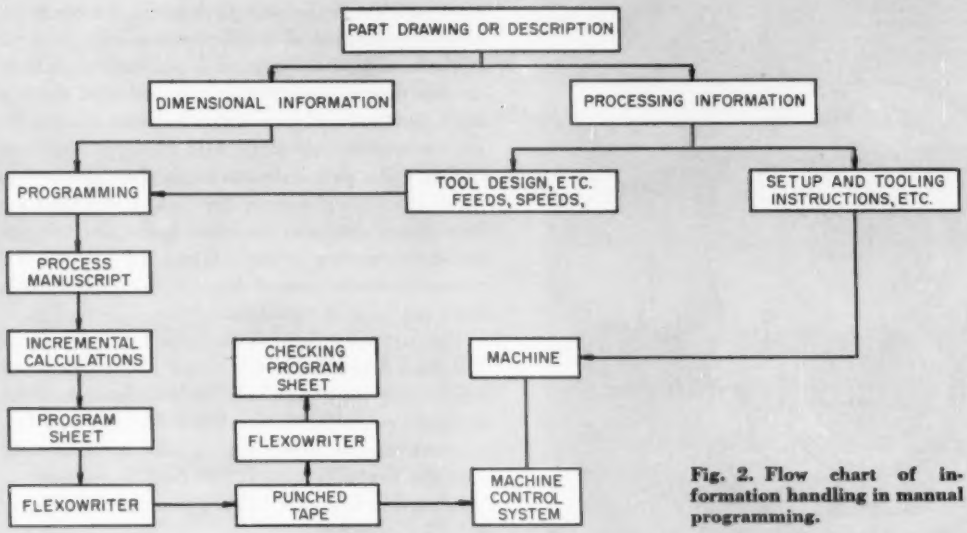


Fig. 2. Flow chart of information handling in manual programming.

punched tape, similar to that used with many positioning systems. Tape language is readily accessible. Instructions are put on the tape as shown in the flow chart, *Fig.* 2. From such taped instructions, slopes are generated at the velocities indicated and the workpiece is ultimately machined.

Programming without a computer can best be illustrated by the actual steps required to program and produce a sample part, *Fig.* 3. The operations on this part are: (1) mill the flange face; (2) drill 14 holes; (3) mill the O-ring groove. Bores *A* and *B* locate all machining operations.

Plane Surfaces: Movement along a straight line on the workpiece can sometimes be scaled directly from the part drawing, as for traversing in air, wide-tolerance roughing cuts, or facing cuts. To mill the flange face, the *Z* axis is accurately set, while *X* and *Y* movements do not require great precision for facing the piece. The facility offered part programmers by Cartesian dimensioning has made it standard to recommend that drawings of workpieces to be produced under numerical control be dimensioned from base lines on a Cartesian grid. Oftentimes the points that define the pieces are listed in a table accompanying the drawing for the convenience of the part programmer. When the workpiece is dimensioned on a Cartesian grid, the amount of movement from one point to another is easily found by subtracting the coordinate values of one point from the coordinate values of the next point. That is, to move from Point 1 to Point 2:

$$X_2Y_2 - X_1Y_1 = \Delta X \Delta Y$$

where X_1Y_1 are the coordinates (in the XY plane) of the first point, X_2Y_2 are the coordinates of the destination point and Δ is the difference in values obtained for any axis. If the coordinates of Point 1 are $X = 3$, $Y = 2$ and the coordinates of Point 2 are $X = 6$, $Y = 6$, then $\Delta X = 3$ and $\Delta Y = 4$. By simple subtraction of coordinate values, the "incremental calculation" function shown in the flow chart, *Fig.* 2 is easily completed.

When a workpiece is not dimensioned in Cartesian coordinates, as with the flange, preliminary calculations are required. Polar-to-Cartesian conversion is obtained by $X = R \cos \theta$ and $Y = R \sin \theta$. For the cluster of holes located about Bore A, the center of the bore is used as the origin of a set of coordinate axes and Hole 1 is defined as being 0 deg by convention. Cartesian coordinate values for the three holes in the first quadrant are readily determined from the accompanying table.

Since the holes in the second quadrant are symmetrical to those in the first quadrant, ΔX and ΔY values for the second quadrant are obtained by changing signs. Coordinates of the holes at the intersection of both bolt circles are given on the drawing and need not be calculated. Bore *B* and its associated bolt circle is a mirror image of Bore *A*; only sign inversion of the increment of movement is required to indicate the cutter path from hole to hole. For the flange, a program stop is entered by the part planner after all holes are drilled to enable the operator to change to a ¼-inch end mill. The tool is then returned to the center of Bore *A*.

Though hole drilling is basically a positioning job, the same calculation methods are applicable for straight-line cuts, as for example if the flange

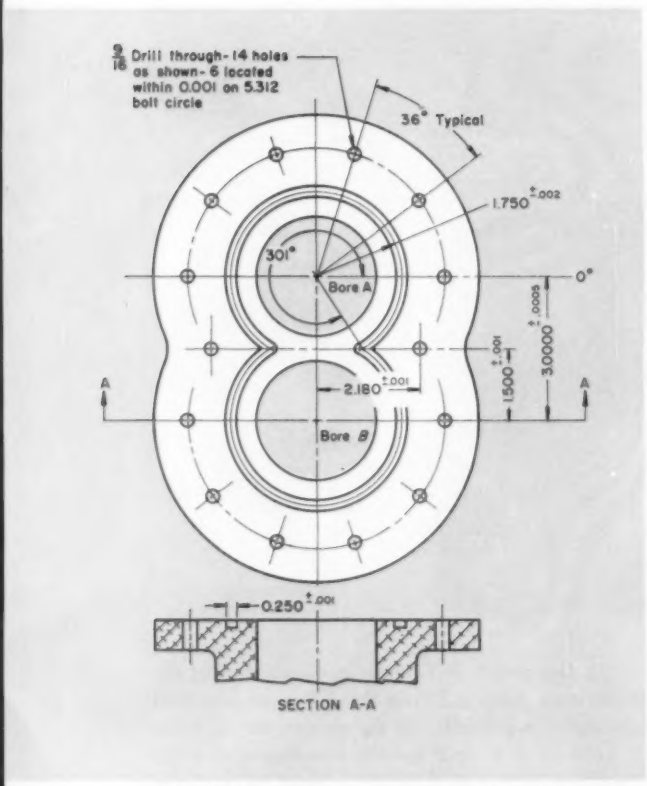


Fig. 3. Pump flange, sample part for which a tape is developed by manual programming.

perimeter were a partial decagon inscribed in the bolt circle. Much of the machining encountered in average workpieces consists of straight lines and is programmed as easily as positioning work.

Curved Surfaces: Machining the O-ring grooves requires computing a tool path for arcs. Because this control unit drives machine axes linearly and simultaneously to generate slopes, any arc must be considered as a series of connected short straight-line chords that approximate a circle.

A chord length must be selected that satisfies workpiece tolerance requirements. For the O-ring groove, tolerance is given as ± 0.002 inch. The angle that defines an acceptable chord length is determined by

$$\cos \frac{\alpha}{2} = \frac{\text{Lower Limit Radius}}{\text{Upper Limit Radius}} = \frac{1.748}{1.752}$$

$$\alpha = 7 \text{ deg } 34 \text{ min}$$

Once α is found, chord end-points satisfying the tolerance can be found. The coordinates of one end point are then subtracted from the coordinates of the succeeding end point. Incrementing tables calculated for various α increments eliminate much of the calculation work that would otherwise be required. The 6-deg incrementing table, *Fig.* 4, is the most suitable of the several available for the tolerance requirements of the O-ring groove.

Machining of the groove is planned to start in the fourth quadrant, at the intersection of the two arcs. The path moves counterclockwise around the arc centered around Bore *A* to the opposite intersection. The path information is then inverted to travel the cutter around the groove centered on Bore *B* and return to the initial point. By triangulation, the starting point is found to be at 301 deg counterclockwise from 0 deg. Its Cartesian coordinates can now be calculated.

The first point listed in the table after 301 deg is 306 deg. Accordingly, the *X* and *Y* coordinates of the 306-deg point must also be calculated in order to begin using the table. From 306 deg onward, counterclockwise about the arc, the table is used until the next-to-last point (84 deg) is reached.

In moving from the 306-deg point to the 312-deg point for example:

$$\Delta X = R\, f(X) = 1.750\ (0.08135) = 0.1424$$

The circle radius is locked into the desk calculator and the *X* and *Y* factors successively entered. Calculation is stopped at the next-to-last point to make a compensation for roundoff error. This is a precaution for accuracy even though roundoff is theoretically self-cancelling.

Roundoff error is determined by comparing the coordinates of the incremented position with the coordinates of the geometrically true position. To find the *X* coordinate of the incremented position, the following can be used, where *i* is the coordinate at the initial position and *f* the coordinate at the final position:

$$X_i + (\Delta X_{i+1} + \Delta X_{i+2} \ldots\ldots \Delta X_{f-1}) = X_{f-1}$$

If a difference between the incremented position and geometrically true position exists, the path to the final point is adjusted so that ΔX_f and ΔY_f bring the cutter to the geometrically true position.

Feed Rates: Knowing the point-to-point increments of movement of each axis enables determination of total movement along all axes. This is found by using the expression:

$$d = \sqrt{\Delta X^2 + \Delta Y^2 + \Delta Z^2}$$

where *d* is the vector sum of *X*, *Y* and *Z* axis move-

Calculations for First-Quadrant Hole

Hole (No.)	Θ (deg)	X (in.)	Y (in.)	ΔX (in.)	ΔY (in.)
1	0	2.656	0.0	2.656	0.0
2	36	2.1488	1.5611	-0.5072	1.5611
3	72	0.8208	2.5260	-1.3280	0.9649

ment. More simply, the cutter path can be sketched on the drawing as the path is developed and the drawing simply scaled to find d, as greater accuracy than this is not usually needed for feed rates. For circular arc cutter paths, all the chord lengths derived from the incrementing table are identical and will have the same feed number.

The feed rate information fed into the control system is basically some quantity of time. Some length of cut, d must be done at some specified rate. To do this, the control system measures and controls the time, f given by the expression:

$$f = \frac{10\ (r)}{d}$$

where r is the desired rate in inches per minute. For example, traversing 4 inches at 200 ipm:

$$f = \frac{10(200)}{4} = 500$$

Tape format requires that f be encoded as a 3-digit number whose left-most digit is a multiplier m, so that the encoded feed rate number is of the form mtu, where t is the "tens" digit and u the "units" digit. When f is ≤ 99, $m = 1$ and causes multiplication by 1 in the control system. When $f \geq 100$, $m = 2$ and causes multiplication by 10 in the system. Thus, an f of 500 is encoded as 250 and translated by the control unit as 10(50). Similarly, an f of 290 is encoded as 229, 060 is encoded as 160 and so forth.

The last stage in programming is to punch the cutter path information on tape. Using a Flexowriter, a typed copy of the handwritten manuscript is produced as the tape is punched. The typewritten copy, *Fig.* 5, is used for checking the accuracy of transcription. A final check on transcription, punching and reading accuracy can be obtained by monitoring the information at the display of storage register contents. There is also a provision for manually inserting data in case any block needs to be changed.

Incrementing Table (6-deg)

α	Cos α	Sin α	*fX*	*fY*
6	0.99452	0.10453	−0.00548	0.10453
12	0.97815	0.20791	−0.01637	0.10338
18	0.95106	0.30902	−0.02709	0.10111
294	0.40674	−0.91355	0.09772	0.03751
300	0.50000	−0.86603	0.09326	0.04752
306	0.58779	−0.80902	0.08779	0.05701
312	0.66913	−0.74315	0.08135	0.06587
318	0.74315	−0.66913	0.07401	0.07401
324	0.80902	−0.58779	0.06587	0.08135
330	0.86603	−0.50000	0.05701	0.08779
336	0.91355	−0.40674	0.04752	0.09326
342	0.95106	−0.30902	0.03751	0.09772
348	0.97815	−0.20791	0.02709	0.10111
354	0.99452	−0.10453	0.01637	0.10338
360	1.00000		0.00548	0.10453

Fig. 4. Incrementing table for chordal circle approximation. The 6-deg increments are for counterclockwise movement. For clockwise movement, *fX* and *fY* are multiplied by minus one.

△X	△Y	△Z	FEED NO.	COMMENTS
+00000	+00000	−00320	299	PART 1 FACE MILL
+00000	−20000	+00000	179	
−20000	−20000	+00000	154	
−15000	−15000	+00000	170	
+05000	−10000	+00000	210	
+05000	−10000	+00000	210	
−05000	+05000	+00000	221	
+00000	+00000	+50000	240	
+00000	+00000	+00000	299	PROGRAM STOP
+26560	+00000	+00000	177	CHANGE TO 9/32 DR.
+00000	+00000	−07500	120	PART 2 DRILLING
+00000	+00000	+07500	227	
−05072	+15611	+00000	299	
+00000	+00000	−07500	120	
+00000	+00000	+07500	227	
−13280	+09649	+00000	299	
+00000	+00000	−07500	120	
−21800	+15000	+00000	277	
+00000	+00000	+00000	299	PART 3 PATH MILL
+09013	−15000	+00000	299	301°
+00000	+00000	−02550	266	TOOL PLUNGE
+01273	+00842	+00000	299	306°
+01424	+01153	+00000	280	312°
−01809	+00286	+00000	280	84°
−01829	+00096	+00000	280	90°
−01829	−00096	+00000	280	96°
−01809	−00286	+00000	280	102°

Fig. 5. Typewritten transcription of taped information used for machining the sample flange.

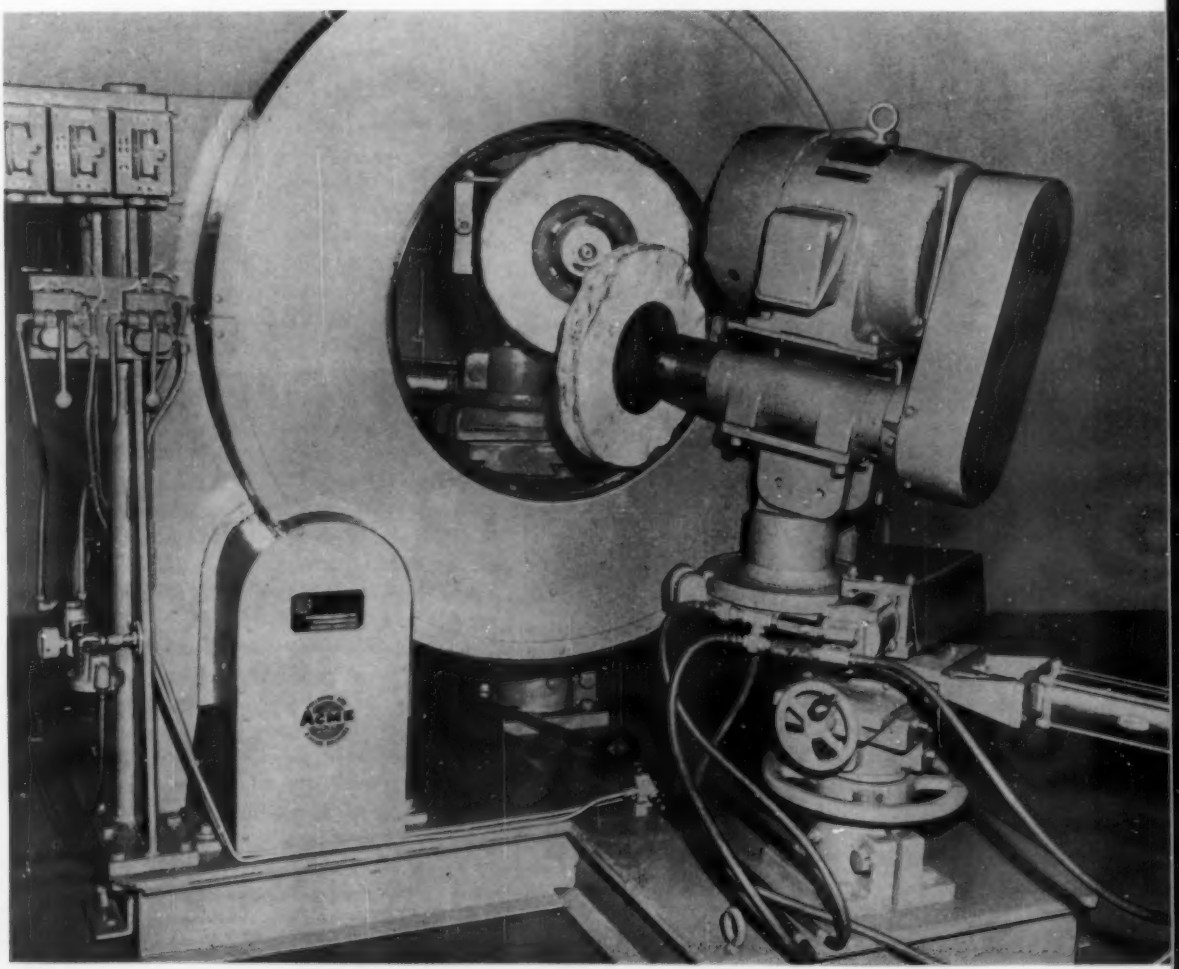
The possibilities of hand programming are only partially revealed by this one example. More complex workpieces can be readily programmed. And many workpieces where the cutter path is primarily in *X Y* are easier to program than the flange, especially if the drawing is laid out on a Cartesian grid. On the other hand, computers are less prone to error than humans, faster and for complex workpieces, more economical. For swarfed workpieces, 4-axis work, and jobs involving much computation, the computer is probably more suitable, though it is possible to produce the tape by hand programming. However, hand programming does bring the advantages of numerical control to shops not equipped with computers, or where access to computer facilities is limited. It enables entry into numerical control without the initial cost of a computer—computer acquisition or rental can oftentimes be justified later out of cost savings achieved by numerical control. And the hand programming work is an excellent means for tool engineers to learn numerical control programming so that phasing into computer use is smooth and efficient.

designed for
PRODUCTION

Pneumatic Cylinders Position Buffing Heads

Buffing heads are moved in and out of position by pneumatic cylinders in this polishing machine, a product of Acme Manufacturing Co., Detroit. Actuation of the cylinders is accomplished by manual control or by an automatic timer.

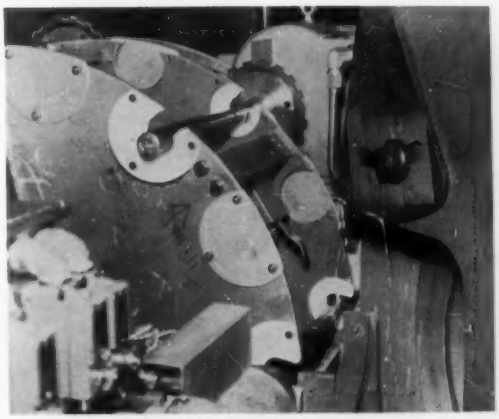
Upon start of a cycle, the rim is locked in position by an air-actuated scroll chuck which controls concentricity and pressure. The heads—located in an outward position during loading—swing into operating position when buffing begins.



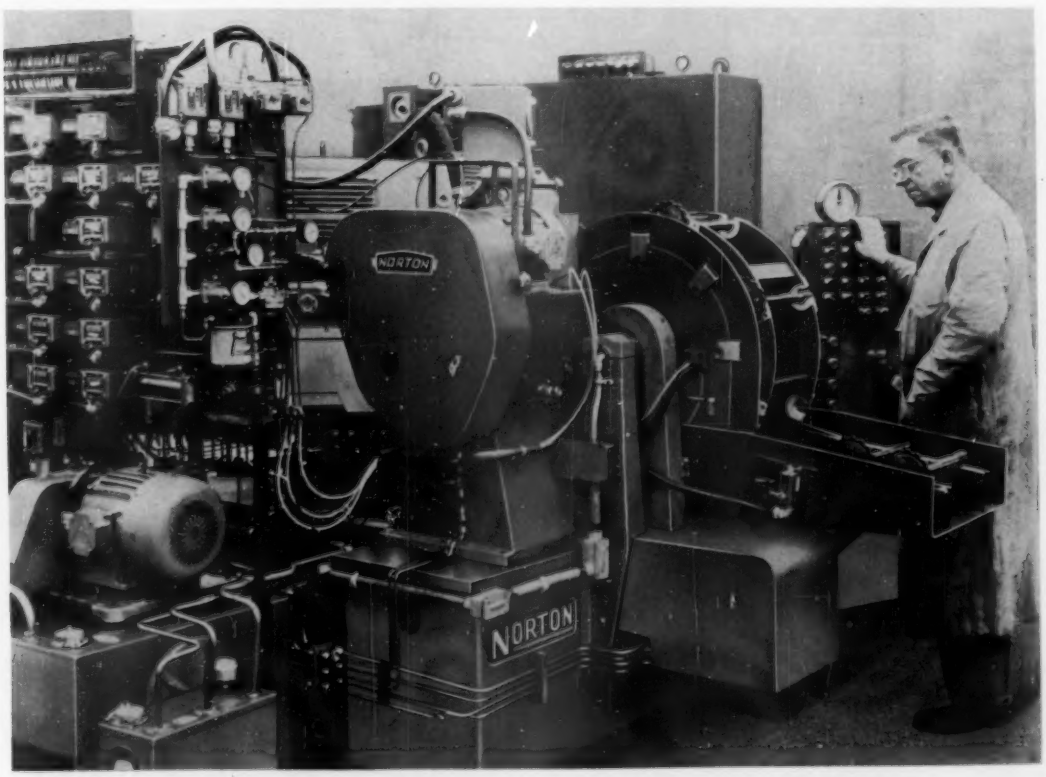
Turret Loader Feeds Grinder

Workpieces are transferred to and returned from grinding stations by a turret work loader in the Norton transfer machine illustrated. Moving down an inclined slide, the workpiece nests in notches in the loader. The loader, indexing after grinding, carries the work around to a return track from which it is transferred to subsequent stations.

Upon arrival at grinding position the workpiece is picked up by centers which move in automatically. Pickup by the centers relieves the part of physical contact with the loader although it remains in its notch during grinding. At completion of grinding, centers withdraw and the finished part is indexed out of grinding position.



TURRET LOADER presenting workpiece to wheel. This station grinds angular faces.



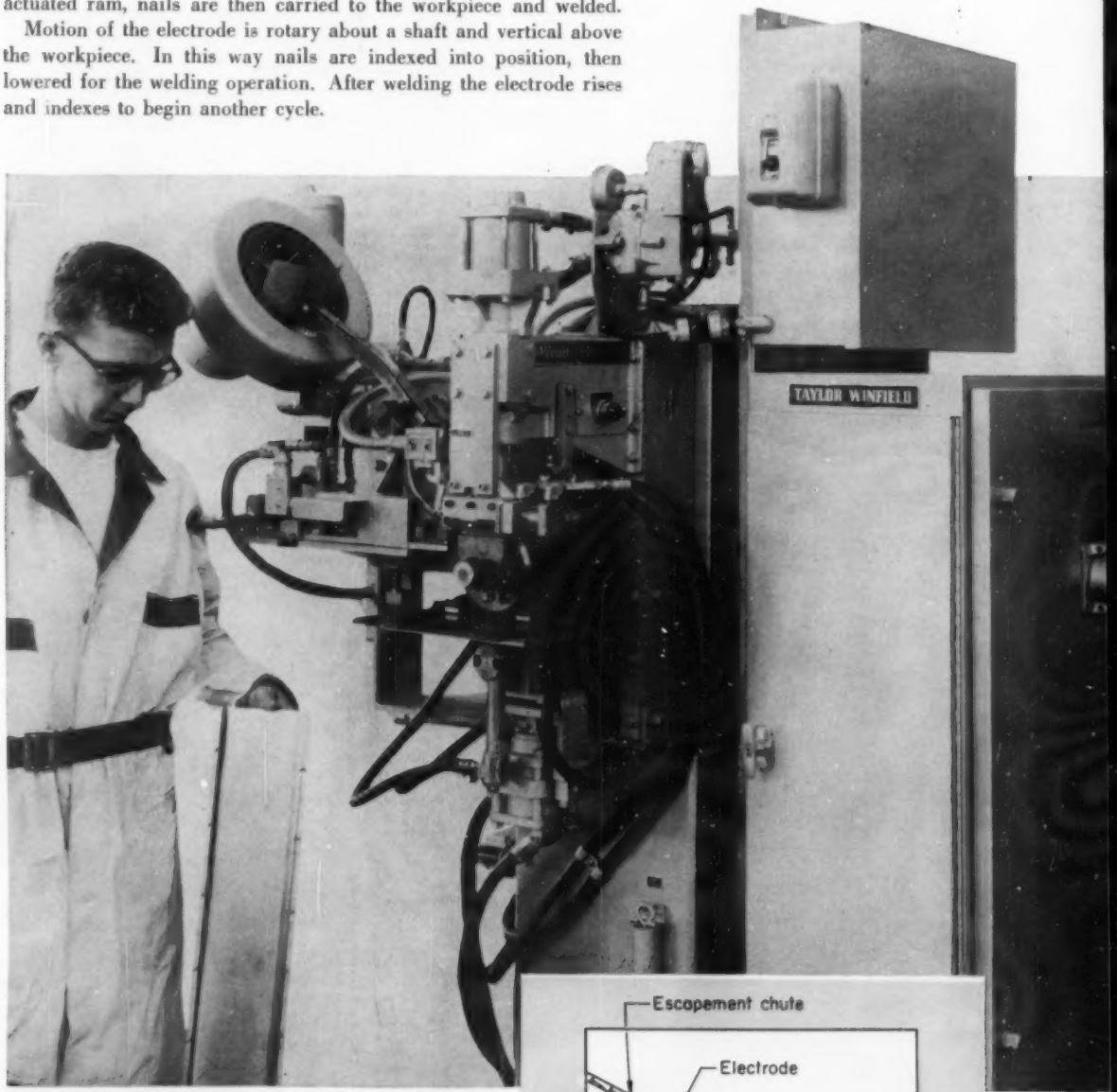
FINISHED PARTS emerging from loader at last station. In preceding stations finished parts are automatically transferred to subsequent stations.

DESIGNED FOR PRODUCTION

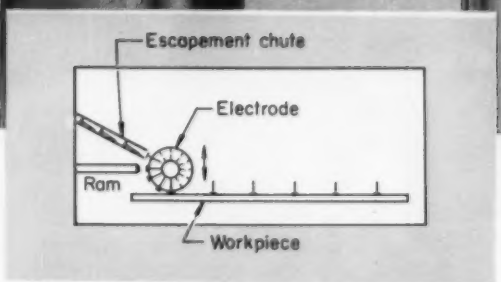
Rotating Electrode Welds Automotive Trim

Designed to weld nails to automotive trim, this Taylor Winfield welder utilizes a rotating electrode for nail pickup, placement and welding. As nails emerge from a hopper escapement device they fall into holes in the electrode. Fixed in the electrode by an air-actuated ram, nails are then carried to the workpiece and welded.

Motion of the electrode is rotary about a shaft and vertical above the workpiece. In this way nails are indexed into position, then lowered for the welding operation. After welding the electrode rises and indexes to begin another cycle.



WELDING MACHINE and finished workpiece. Rotating electrode is visible immediately above platen.

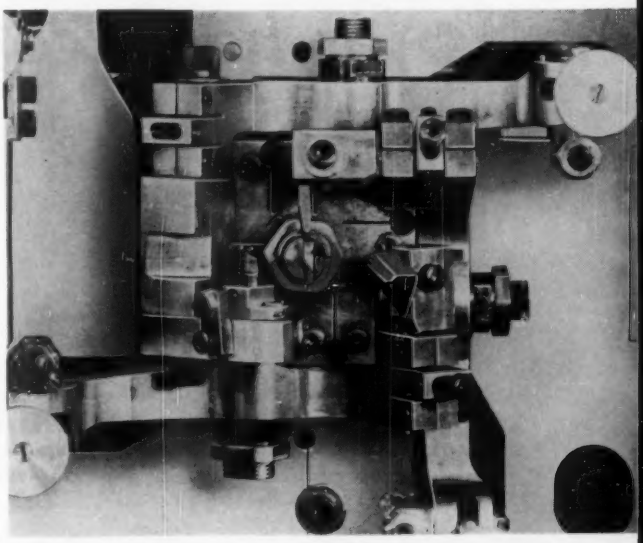


SCHEMATIC DIAGRAM of electrode operation. Workpiece is positioned manually.

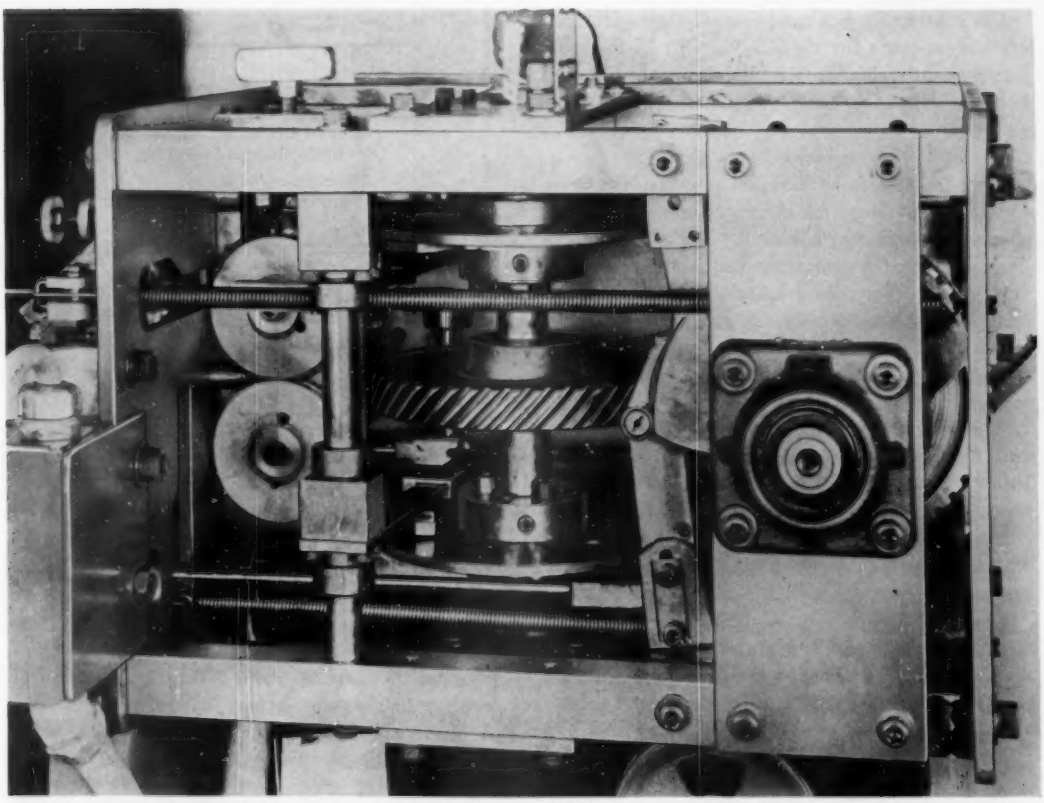
Coiler Automates Spring Production

Formation of end loops and hooks on springs is accomplished by two cam-actuated looping tools in this machine. These operations—performed before and after coiling—make it possible to manufacture springs as a one-cycle operation. The machine forms one loop, coils the springs, forms the second loop and then cuts off the wire.

Change gears are utilized to establish desired lengths by controlling the rate of wire feed. The shape and size of the end loops is controlled by cams and cam inserts. Designed and built by The Baird Machine Co., the coiler can be adapted to any size and shape of spring within machine limits by altering gear ratios and cam design.



TOOLING AREA of the spring generator. Looping tools, above and left of center, control size and shape of end-loop formation.



MECHANISM of coiler. Twin disks (left) feed wire to tooling area. Cam (right) actuates looping tools.

CHEMICAL MILLING
of honeycomb core blanket

By Raymond G. McCue
Design Engineer
Design Producibility Dept.
North American Aviation, Inc.
Los Angeles, Calif.

WITH THE ADVENT of supersonic aircraft, manufacturing engineers have had to develop new approches to production. The XB-70 weapons system, currently being designed, is a case in point. Hard materials such as René 41, a corrosion-resistant nickel-base alloy; H-11, an ultrahigh-strength hot-work die steel; and several hard-to-machine titanium alloys are used in the construction of this manned aircraft. Machining tolerances are smaller than for any previous aircraft.

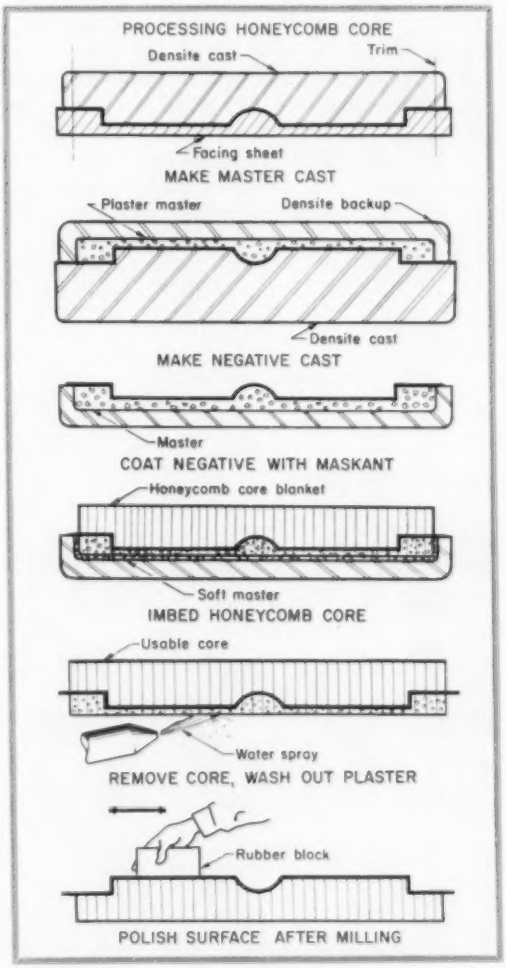
Chemical milling is used extensively to fabricate component parts for the XB-70. One of the more interesting developments is the chemical milling of honeycomb core to match stepped face sheets. Conventional machining of the honeycomb to match these sheets is considered impractical.

Steps in chemical milling are shown in the drawing. In preparation for chemical milling, the face sheet (which is also chemically milled) is placed on a surface table and covered with a sheet of vinyl plastic. The plastic is sealed around the edges and air is exhaused from the area covered by the plastic. Atmospheric pressure forces the face sheet flat against the table, removing any distortion that may be present.

A retaining box is then placed around the sheet and filled with a special Densite plaster. This forms a plaster cast of the inner surface of the face sheet. After curing, the Densite cast is turned over and a negative cast is poured, using soft plaster with a reinforced Densite backup. The soft plaster cast is a duplicate or master of the face sheet.

Following a curing cycle, the master is removed from the Densite cast and coated with a 3/16-inch-thick maskant. The honeycomb core blanket is then pressed through the maskant into the plaster master to a predetermined depth. Then the Densite backup is removed and the soft plaster, which is water-soluble, is washed away from the exposed cell walls.

After the excess core material is chemically milled, the maskant surface is hand-polished, using a block and fine-grit emery cloth to remove any remaining metal. The maskant is then removed. After cleaning, the core blanket will fit the facing sheet within a 0.004-inch gap allowed for brazing.



From Paper 326, "Designing Producible Airframes from Superalloys," presented at the ASTME 28th Semiannual Meeting. Copies of the complete paper are available from Society Headquarters.

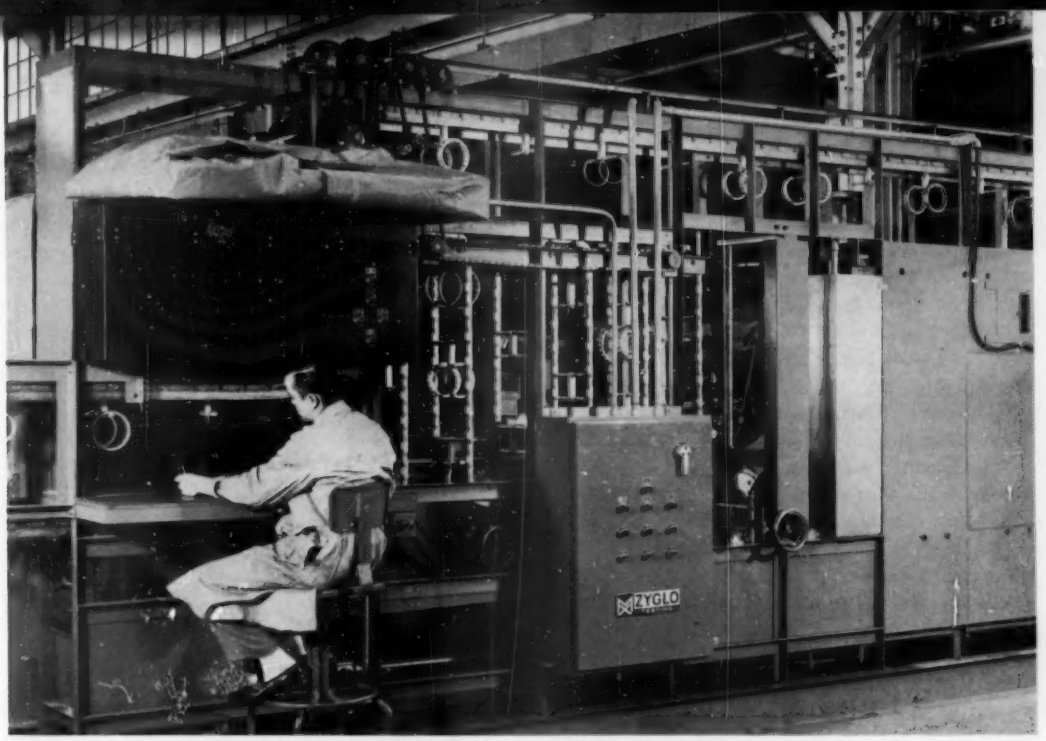


Fig. 1. Magnetic-particle testing unit for inspecting ball separators. All operations except loading and unloading are automatic.

method control in testing —key to reliability

By A. E. Christensen
Chief Engineer
Mechanical and Electrical
Magnaflux Corp.
Chicago, Ill.

Without adequate control of inspection methods, nondestructive testing is only marginally effective. Theory and practical application of method control are discussed by the author.

PRINCIPAL OBJECTIVES in the use of nondestructive testing are increased component reliability and dollar savings in inspection. Both objectives are critical and either one can be of dominant importance depending on the end use of the parts tested. As examples, nondestructive testing can be utilized in one plant for inspecting wrenches and in another for detecting failure in missile components. In the first plant the user is primarily interested in the economies of the system. In the other his immediate concern, for obvious reasons, is component reliability. Because either system is subject to a number of variables, its integrity depends largely upon method control—the extent to which the variables in the inspection process are controlled.

Magnetic-Particle Testing: Problems of method control in magnetic-particle testing, *Fig.* 1, typify those found in other forms of nondestructive testing. In this process "indications" are formed by the attraction of finely divided magnetic particles to a leakage field in a magnetized part. The magnetic particles are applied as dry powder or as a suspension in an oil or water vehicle. The magnetic field is usually introduced by passage of a current either through or around the part being tested. In *Fig.* 2, it is passed longitudinally to detect transverse defects. In *Fig.* 3 the field is circu-

lar for detection of longitudinal defects.

Three methods of particle application are possible: continuous, continuous-residual, and residual. In the continuous method, particles are applied only during current flow. In the residual method they are applied after cessation of flow. The continuous-residual method, as the name implies, is a hybrid and magnetic particles are applied to the test piece both before and after current flow.

Control of Variables: The variables which influence this form of testing can be classified in one of two groups: variables by choice and variables by accident. Paramount among the variables by choice are the metallurgical characteristics of the part. These influence the part's ability to retain a strong magnetic field and consequently, the extent to which particles are attracted to indications. Other variables by choice include geometry, surface finish, magnetizing current level and particle concentration. Geometry and surface finish are critical in holding the particles at indications during drain-off of the oil or water vehicle. Current level establishes the strength of the magentic field, and particle concentration determines the number of particles retained at the indications.

Variables by accident usually involve human factors and, as such, they are equal in importance to variables by choice. As an example, if a part requiring a high level of reliability is inspected by the continuous method on a standard wet type unit, the following variables can affect the reliability of the test.

1. Poor part placement between heads. This results in part burning, poor current flow and a weak magnetic field
2. Premature start of current flow. Initiation of flow before clamping has been completed results in burning and physical damage to part
3. Premature application of suspension. This can cause premature drain-off in the magnetizing cycle. Result: minute defects are not disclosed
4. Tardy application of suspension. If suspension is applied after cessation of current flow, indications at minute defects are washed off
5. Premature unclamping. If current is still flowing during unclamping, the part will be burned
6. Part removal for examination. This can result in smeared indications.

Although it is unlikely that all of these factors would occur in any given case, the occurrence of only one of them would result in an inaccurate test or a burned part.

Possible corrections of these difficulties range from simple fixturing to conveyorization and mechanical handling. In the hypothetical example cited, it would be neither difficult nor expensive

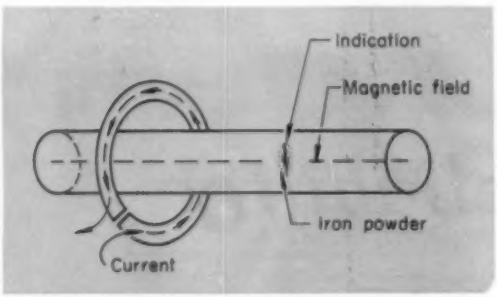


Fig. 2. Longitudinal magnetic field created by circular current flow around a cylindrical workpiece.

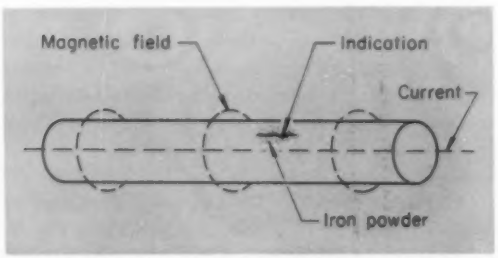


Fig. 3. Circular magnetic field created by longitudinal current flow.

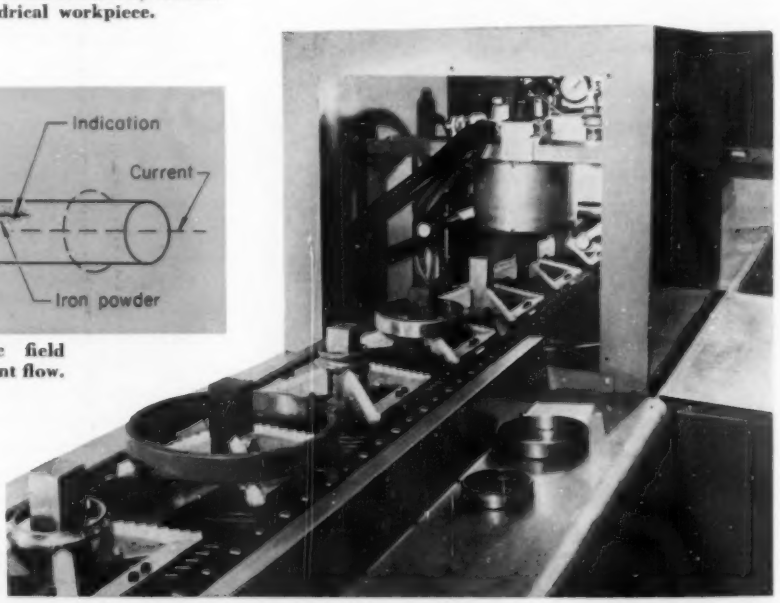


Fig. 4. Nondestructive test unit for inspecting ball races. Unoccupied fixtures are for additional inspection in second station of machine.

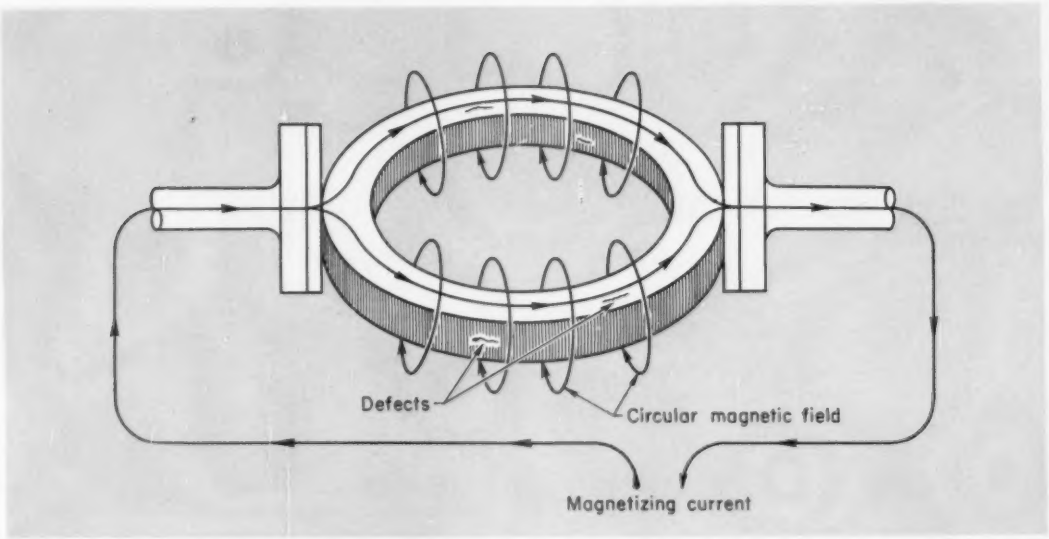
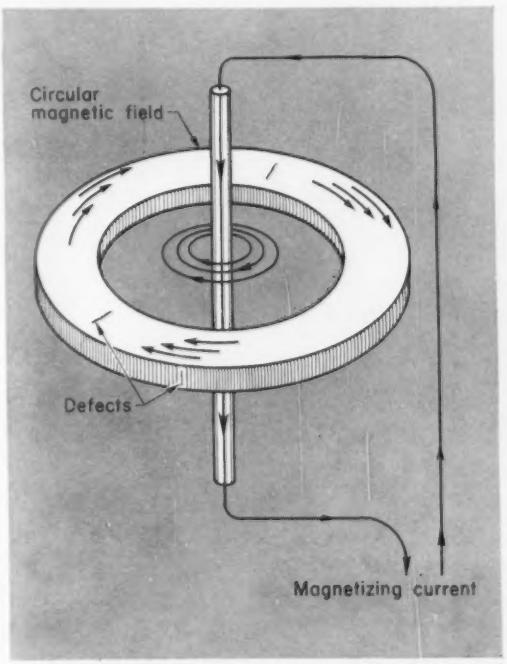


Fig. 5. (above) Customary method of detecting circumferential defects. For thorough inspection, part must be indexed 90 deg and inspected again.

Fig. 6. (right) Radial and axial defects are detected by induced current from central conductor.



to tool a standard unit for proper part positioning and automatic cycling. The cycle would include clamping, magnetizing, bath application and unclamping. Operator functions would then be limited to visual examination of defects. Only when such setups fail to provide required production should more complex control systems be designed.

Bearing-Race Inspection: The benefits derived from method control are exemplified in the advanced techniques used to inspect bearing races, *Fig.* 4. In conventional bearing inspection, circular magnetization for disclosure of axial defects is generally effected by a central conductor, *Fig.* 5. Circular magnetization is also employed across the diameter to detect circumferential defects, *Fig.* 6. Because the magnetic field is distorted near the point of contact, two inspections, 90 deg apart, are required. This method is hazardous in that it provides two opportunities for the system to go out of control and it requires accurate manual indexing.

By contrast, the advanced technique, schematically diagrammed in *Fig.* 7 utilizes induced current to disclose circumferential defects. In this method the part becomes, in effect, a one-turn secondary in a transformer, with the magnetizing coil acting as the primary. The rapid collapse of high-level direct current in the primary induces circulating eddy currents in the part. This, in turn, induces a toroidal magnetic field which discloses circumferential indications.

The application of this method to a high-volume inspection line is illustrated in *Fig.* 4. Races, placed on every other fixture at the load station, proceed through a magnetizing station where they are processed for radial flaws. A central conductor establishes the field. After passing this station, parts are examined for defects and then placed on the alternate fixtures for examination of circumferential flaws. After advancing through the second station, inspected parts are placed on an overhead ramp and rolled through a demagnetizing coil. Although highly productive, this unit is justified

Fig. 7. (right) Induced current method of detecting circumferential defects in workpiece.

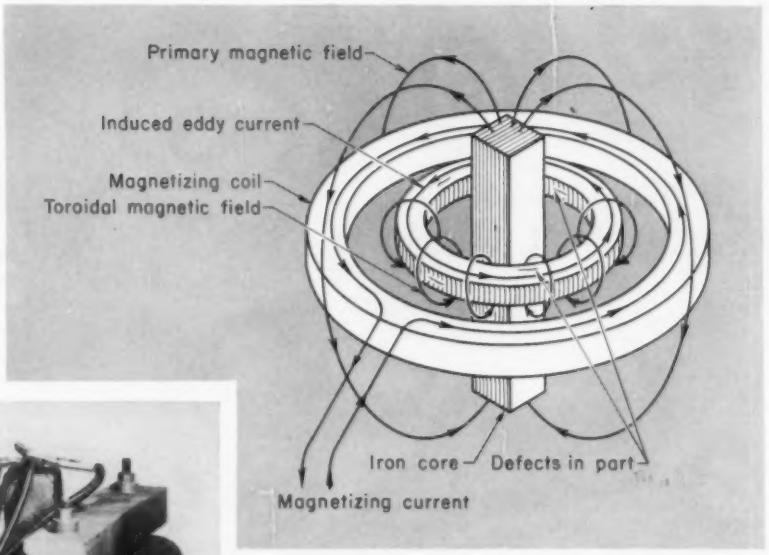


Fig. 8. (below) Over-all magnetization used to inspect casting. Fluorescent magnetic particles are used in this test.

primarily because of its method of part control. Production is a secondary factor.

The inspection of components such as mainbearing balls presents another example of the need for method control in nondestructive testing. Normally balls cannot be tested accurately by coil magnetization because of their shape. In order to detect all possible flaws, the ball must be treated as a cube and subjected to circular magnetization in three axes. This is made practical by a special unit which shifts the ball into the three requisite stations. To eliminate burning from point contact, induced current is used. Here, as in the preceding example, reliability is insured by perfect control of the part throughout the entire inspection cycle.

Inspection Of Castings: In many cases contact prods are used to inspect complex weldments and castings. Generally two men are employed in this task—one handling the prods and the other applying magnetic particles. At best this is a laborious task. The operators must synchronize their operations and, if inspection is thorough, they must cover the entire workpiece in a checkerboard pattern. Because perfect synchronization and complete coverage are unlikely, these jobs represent another potential application of method control. An improved method now used in many plants eliminates human variables by subjecting the workpiece to prolonged current exposure. Intensity of the current can vary from 5 to 20,000 amp depending on individual part requirements. During current exposure magnetic particles are applied and the part is examined visually for indications, as shown in *Fig.* 8.

Improved Inspection: Because test results are valid only when variables are controlled, certain basic rules regarding their control can be summarized.

1. Methods and techniques of testing should be selected on the basis of component reliability
2. All variables subject to control should be established
3. Operators should be relieved of control responsibility
4. Method control should not be sacrificed for increased versatility.

The philosophy implicit in the preceding rules is simple: it calls for elimination of the operator as a factor in inspection control. The extent to which this is accomplished is often the difference between total and marginal effectiveness in nondestructive testing systems of any type.

drilling holes to size ...in one operation

By Frank Zagar
President
Zagar, Inc.
Cleveland, Ohio

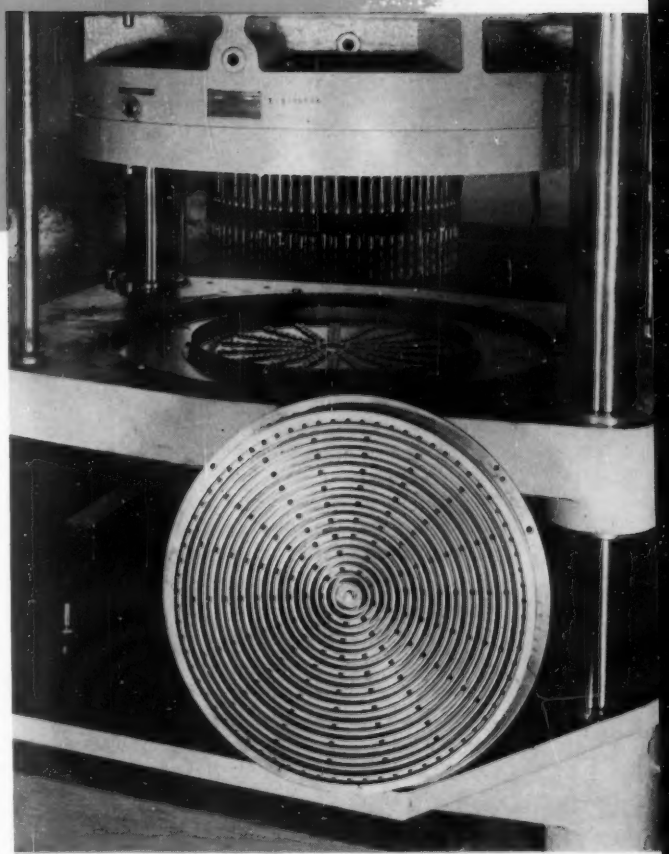


Fig. 1. Setup for drilling multiple holes in a heat exchanger plate. Holes are 5/16 inch in diameter and must be to size within ±0.001 inch.

The tendency of drills to cut oversize can be minimized by using step drills. Even when the pilot is started in an offset position, the body portion of the drill will cut to correct size.

DRILLING HOLES to close size tolerances (±0.001 inch) in one operation is of particular importance in the manufacture of heat exchanger tube sheets, *Fig.* 1. Hundreds of holes are drilled simultaneously. While it would be possible to drill these holes undersize, then ream to final size, the cost of the secondary reaming operation would be high, in terms of man-hours, machine-hours and tools.

Nevertheless, close size tolerances cannot always be maintained with conventional twist drills. In tests in which 500 holes were drilled simultaneously with a multiple-spindle head, about 10 percent of the holes were oversize, despite the fact that the drills used were all new, of the same brand and sharpened on the same precision drill sharpener. The drill bushings were in perfect condition and the feeds, speeds and coolant were exactly the same. Furthermore, on repetitive drillings, the same drills would not always cut oversize.

The reason for the 10 percent failure to maintain size is inherent in the design of conventional twist drills that are sharpened in the usual way. The tests showed that twist drills do not all start in the same manner. About 10 percent of the time they start to cut in an offset position. The resulting holes have a rough appearance and are oversize.

When the 500 conventional twist drills used in the initial tests were reground as step drills, all 500 holes were within size tolerances.

The good results are entirely attributable to the step drill design. When the pilot portion of the

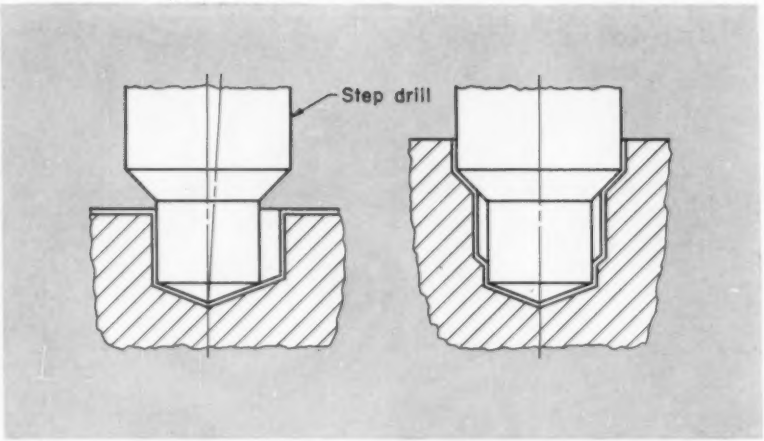
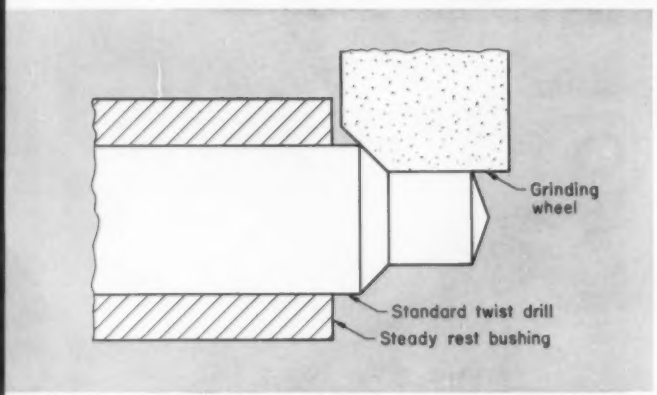


Fig. 2. (right) When pilot enters the hole (left) it may drill oversize 10 percent of the time. When the drill body enters the hole, however, it centers the pilot, producing a finished hole that is within tolerances.

Fig. 3. (below) Step drill grinding method. Pilot and body diameters must be concentric.



step drill enters the hole, it may, like a conventional twist drill, make a hole that is larger than the pilot diameter, *Fig.* 2. When the body portion of the drill begins to cut, however, it centers the pilot portion of the drill and drills the hole to size regardless of hole depth.

These step drills must be carefully ground. It is essential that the body diameter of the drill be concentric with the pilot diameter. If it is not, the hole will be oversize if the pilot diameter cuts to size to begin with. A satisfactory grinding method is shown in *Fig.* 3.

The length of the pilot should be approximately two-thirds of the major diameter of the drill. It is not necessary that the pilot be completely through the part before the major diameter takes hold.

In general, the pilot diameter should be about three-fourths as large as the major diameter. The pilot must leave sufficient metal so that the body portion of the drill meets enough resistance in cutting to center the pilot. Workpiece softness or hardness must be taken into consideration when determining step drill proportions. The optimum design is best determined by experiment. For longest life, the body portion of the drill should be carbide-tipped.

With care in grinding and with due attention to the condition of drill bushings and other variables that affect drilling performance, the step drills described give excellent results in production.

What Time Is It?

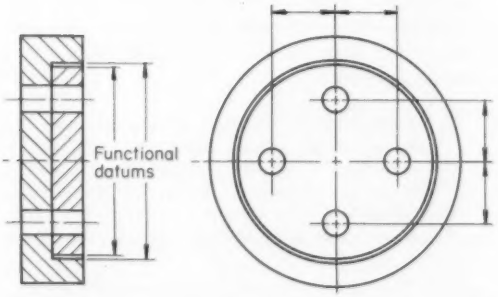
Discussed recently at a National Bureau of Standards conference on standards were some of the problems associated with knowing what time it is, accurately. A satellite-tracking system having an accuracy of 0.1 milliradian, for example, uses a time standard that was designed to have an accuracy of one part in 10^8 or one millisec per day. Atomic beam devices, particularly the two NBS cesium frequency standards have been tested to determine uncertainties in frequency measurements, as when an atomic transition is excited with signals that are not monochromatic. This time measurement system is known as atomic time (A.1). Absolute frequency is based on ephemeris time, ET. The observed and adopted value for the specified cesium line (A.1) is 9,192,631,770 cycles per second.

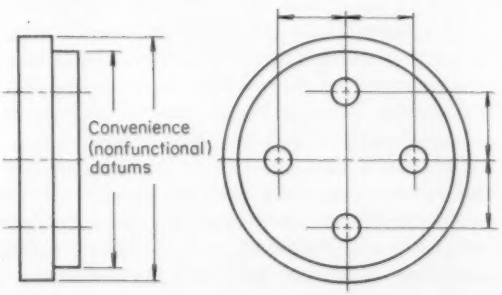
Research on an alkali vapor frequency standard during the past two years has been carried on with the aim of developing a standard for possible use in a satellite-born measurement of the gravitational frequency shift predicted in Einstein's General Law of Relativity. Relative frequencies of several rubidium vapor absorption cells have been shown to remain stable for one part in 10^{11} for a month.

how to use
POSITIONAL TOLERANCES
Part 1—Defining Tolerances

By Edward S. Roth
Staff Member
Manufacturing Development
Sandia Corp.
Albuquerque, N. M.

Ambiguity in bilateral tolerancing can cause high manufacturing costs and reject rates. These unnecessary costs can be eliminated by positional tolerancing, whose three major phases—defining, gaging and inspecting—will be described in three separate articles.





MODERN PRODUCTION, based on parts interchangeability requires manufacturing engineers to be certain that a part made in one plant will fit a mating part made in another plant, perhaps hundreds of miles away. Because of the high cost of producing "perfect" parts, some degree of variance from the norm is generally allowed in the form of tolerances. Wide tolerances permit the use of relatively inexpensive production methods, but with some risk of producing noninterchangeable parts; tight tolerances assure interchangeability, but increase manufacturing costs and reject rates. Tolerances should be stated and measured to allow the widest range possible without compromising interchangeability.

Conventional bilateral tolerances are often ambiguous. They state that a part must be accurate within a certain range. Functional or interchangeability requirements are ignored. This causes manufacturing departments to produce more accurately than is needed, increasing costs. Uncertainty about true interchangeability requirements causes inspectors to reject parts that would be functionally satisfactory. These shortcomings, inherent in bilateral tolerancing can be eliminated by using positional tolerancing, a method of defining, gaging and inspecting tolerances that is based on actual part function and interchangeability.

Defining Tolerances: The first step in applying positional tolerances is defining tolerances. The starting point of the tolerances specification is called a "part datum"—a point of origin and the direction of dimensions and subsequent measurements. To be useful for manufacturing and inspection, the part

Fig. 1. (left) Part datums can be functional as those features on parts that must mate or align to assure function, or convenience (nonfunctional), as outside diameters that do not have to be concentric to assure function of the component.

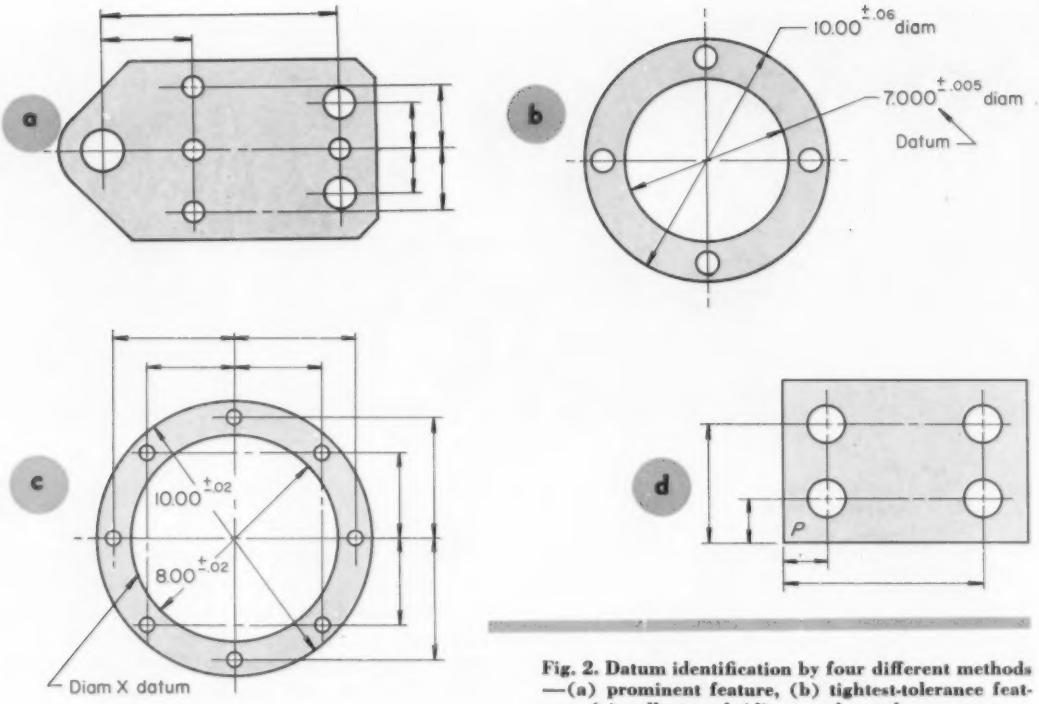


Fig. 2. Datum identification by four different methods —(a) prominent feature, (b) tightest-tolerance feature, (c) callout and (d) a mark on the part.

datum must be accurate, practical, accessible and readily identifiable. Communicating accuracy requirements clearly requires careful attention to datum selection, datum identification and datum qualification.

Selection of a datum is guided by the criteria of function, convenience and economy. A functional datum (a feature on mating parts that fit together or must be aligned to insure function) should usually be selected. In *Fig.* 1a, both hole patterns should be located from the centers of functional mating part diameters to insure interchangeability and function. If the OD of the female part were used as a datum, eccentricity between the OD and the functional diameter could affect interchangeability. Convenience guides datum selection if no single feature is of prime functional importance, as in *Fig.* 1b. In this case, the OD's do not have to be concentric to insure function. The corner of a part can be a convenience datum, specially marked as in *Fig* 2d. Economy is usually realized by using convenience datums, since they are an integral part of the design. Castings and forgings may require specially added tooling holes or machined surfaces to establish datums. When part function does not depend on such datums, they should be eliminated and convenience datums (that might be added during machining operations) used instead, to reduce cost.

Datum identification can be accomplished without ambiguity by any of the methods shown in *Fig.* 2. A prominent and easily identified part feature can be used, such as the large hole in *Fig.* 2a, or the tightest specified tolerance can serve as a datum, *Fig.* 2b. A callout on the drawing, *Fig.* 2c clearly establishes the datum. Similarly, inking or stamping the letter *P* on the datum corner, *Fig.* 2d identifies the datum so that only one corner of the part can serve as the datum.

Qualification of a datum establishes tool, gage and inspection procedures as well as actual part form. Four basic methods are used to qualify a datum accurately:

1. Specify the datum and part form so rigorously that the method of tooling, gaging and inspection is unimportant. Close size tolerances or squareness and flatness callouts, as in *Fig.* 3a, assure datum accuracy
2. Indicate exact tool and gage pickup points as in *Fig.* 3b
3. Combine methods 1 and 2, as is done in *Fig.* 3c
4. Supply production and inspection departments with a gage drawing to clarify the exact datum, *Fig.* 4.

These basic methods apply to any shape datum, but since certain qualification techniques apply solely to either gaging or inspection, the datum specifier should either know these operations well, or consult appropriately prior to qualifying a datum.

Clear communication of actual interchangeability requirements eliminates confusion and cost from manufacturing operations and also paves the way for gaging and inspection, to be described in two succeeding articles on positional tolerances.

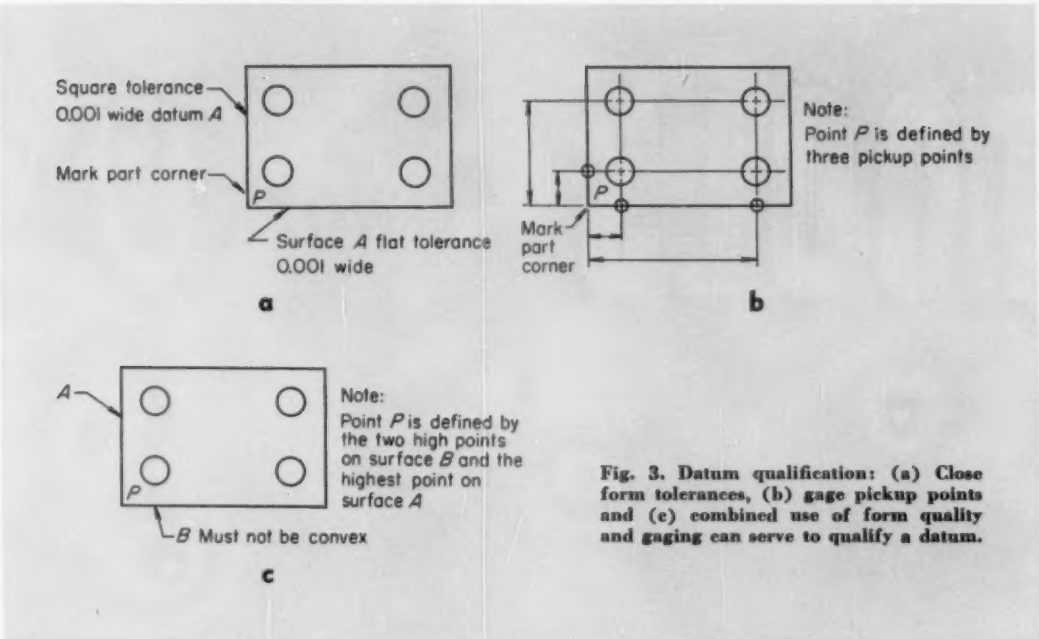


Fig. 3. Datum qualification: (a) Close form tolerances, (b) gage pickup points and (c) combined use of form quality and gaging can serve to qualify a datum.

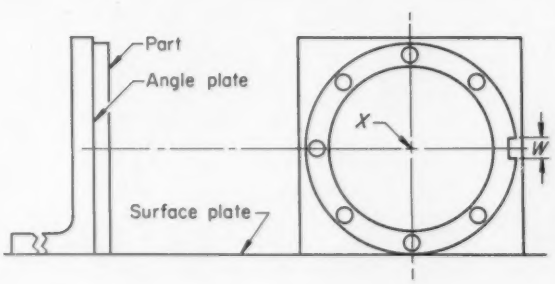


Fig. 4. Datum qualification, achieved by providing a gage drawing. The actual center of diam *X* and width *W* should be set up the same distance from the surface plate.

Wear-Friction Phenomena to Be Studied

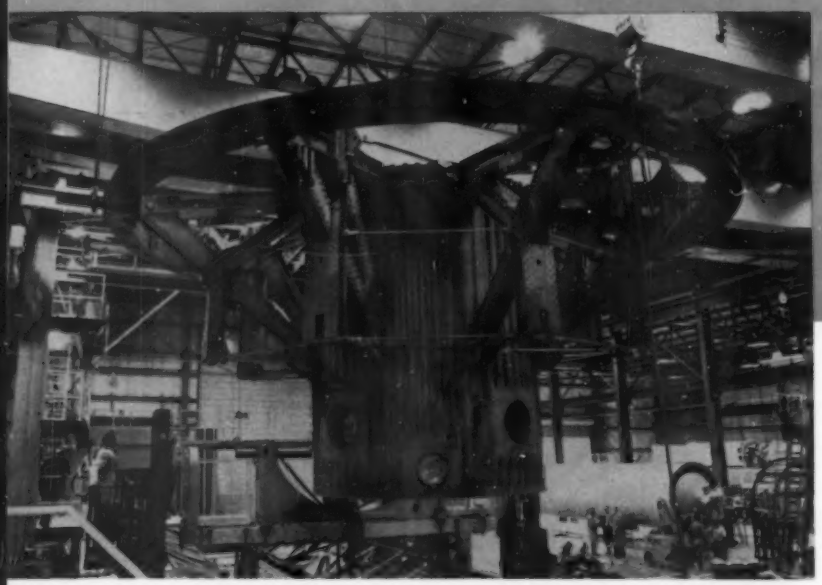
Fundamental research aimed at developing a metal-wear science has united ten nationally known industrial firms in an extensive program now under way at Armour Research Foundation. ARF's scientific team is made up of researchers in metals, mechanics, physics and chemistry. Primary purpose of the three-year, $300,000 research program is to develop an understanding of the complexities surrounding wear-friction phenomena.

For wear and friction are probably the least understood and the most difficult to evaluate of the engineering properties of metals. Man has never really solved the mystery of metal wear, a problem as old as civilization. A solution would aid the selection and development of alloys for bearings, gears, machine ways, and so forth, and would enable manufacturing engineers to save their companies much time, money and effort each year.

Metallurgists who will lead the research team have mapped an intensive and coordinated plan of experiment and data analysis. Using experimental machines, a selected group of alloys will be "forced" to wear. Extent and type of wear will be determined by measuring weight loss, changes in dimension and surface damage. Analysis of wear will be made using x-ray diffraction, electron-microscope, microprobe analyzer, radioactive isotopes and controlled environment laboratories. From the data obtained, general conclusions can be made for the wear and friction of other alloys.

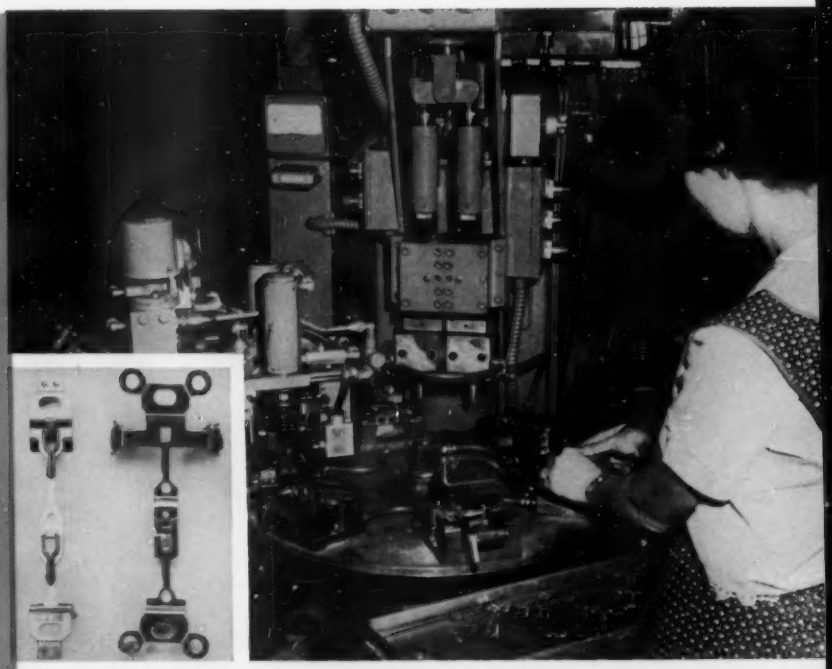
Research personnel at ARF feel that the criteria for success will be their ability to obtain reproducible laboratory information and to relate this information to practical engineering problems.

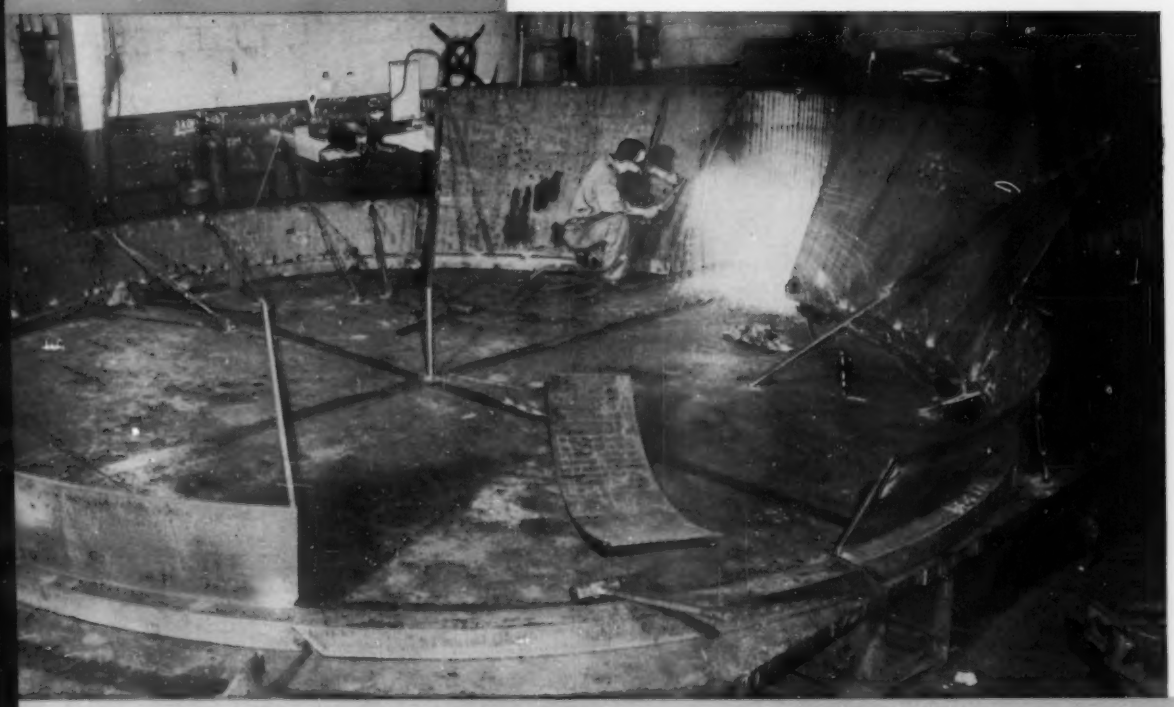
TOOLS at work



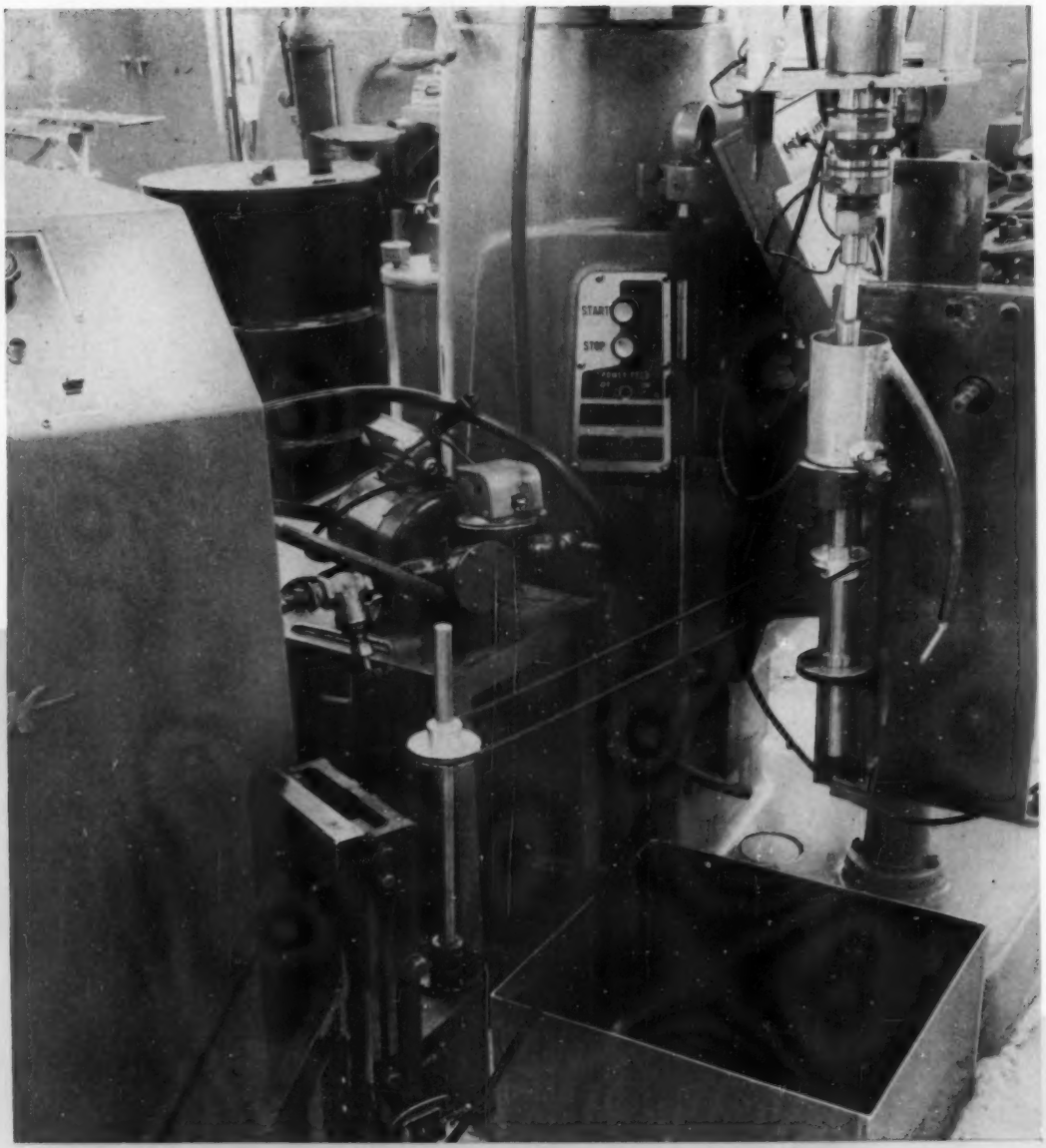
SUPER BOOSTER unit of the Saturn rocket is undergoing static testing at Redstone Arsenal. The Saturn's design objective—lifting multiton loads into high orbit around the earth—imposes severe strength and reliability requirements in its structure, since this super-booster first stage, to be made of a cluster of eight rocket engines, will ultimately deliver a million and a half pounds of thrust. To meet such requirements, a quarter-million missile-quality fasteners and blind lockbolts were used. Lower illustration shows the hydraulic power tool used to install Huckbolt fasteners in a booster outrigger.

FASTENING SUPPORT EARS on a yoke for a duplex electrical outlet is done by resistance welding at Bryant Electric Co. The parts, (at left inset photo), are drawn from hoppers, assembled, welded, formed and ejected automatically. Finished piece (at right in inset) is produced at a rate of 1500 to 2000 assemblies per hour using a 30 KVA Precision welder equipped with six-station Geneva dial feeds.



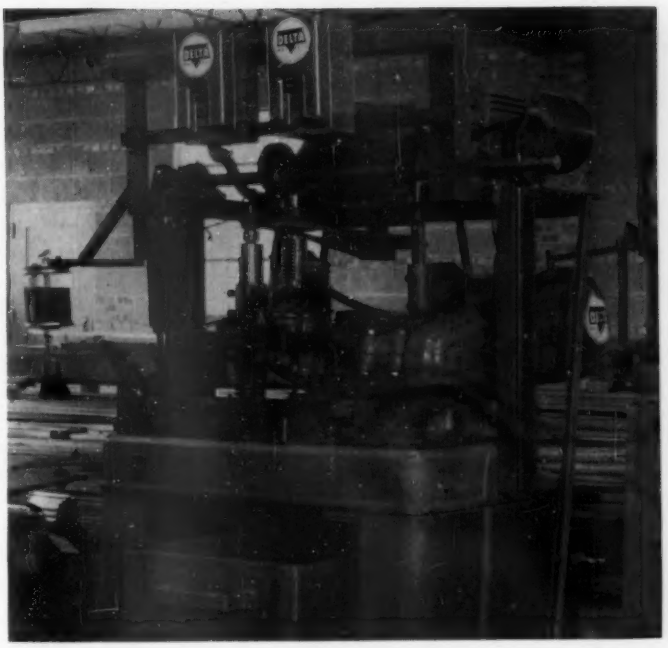


LIKE SEGMENTS of an orange, pieces of ½-inch steel plate are assembled to form a truncated cone for the gas and radiation sealing system of the Enrico Fermi atomic power plant. The pieces are fitted and electric-arc welded at Steel-weld Div. of The R. C. Mahon Co., to be later reassembled at the site. When completed, the shield will flare out from its 18-foot small diameter to a 20-foot large diameter, with a wall height of 5 feet, to conform to the shape of the reactor's primary shielding. Clamping and fixturing are critical because of the close tolerances required to make the seal work.



LONG NARROW HOLES were drilled with high accuracy in molybdenum at Picatinny Arsenal by using this ingenious rig and Elox electrical discharge equipment. A 0.127-inch diam hole was cut through the 20-inch molybdenum probe at about one inch per hour from opposite ends of the piece, meeting in the middle. To minimize runout, a grinding attachment (lower left) was used to rotate the work oppositely from the direction of tool rotation. The work (right, center) was supported by mounting it in line with the spindle on the bedways of a lathe attached vertically to the side of a miller. Using a 0.110-inch-diam Elkonite tool, 2½ shifts were required to complete the hole. The hole was afterward finished to size using a standard 0.125-inch diam brass rod. A circular slot concentric about the central hole and 16.5 inches deep was trepanned using the same equipment. An Elkonite tube with a 0.552-inch OD and 0.385-inch ID served as a trepanning tool. Its tip was spiral-grooved to improve coolant flow. Electrode consumption was one inch for every six or eight inches of penetration. Though not recommended for long-run production, the temporary setup was a successful means of completing a difficult machining job—producing deep holes and slots accurately in the naturally crumbly molybdenum.

PRODUCING DRILLED and tapped sink frame lugs has been mechanized by Drain Enterprises, using standard industrial tools. Three functions—drilling, tapping and cutoff—have been incorporated into one automatic machine. Three cams, mounted on an overhead shaft, control the cycle. The first cam actuates the feed mechanism to advance the extrusion to a positive stop. The second cam actuates the two drill press spindles (one for drilling, one for tapping) and the third cam, the cutoff saw. Completed lugs drop into the box. Springs return the spindles and cutoff. For different size extrusions, cams are changed. Delta 14-inch spindles and cutoff saw are used in the operation.



TOOLS at work

AN ALUMINUM HUB assembly for the Sparrow III missile receives seventeen bores in only five setups at Stacy Machine Works. On the first setup, eight piston bores are bored and faced in a manual indexing fixture. Stock removal is 0.083 inch on the semifinish bore and 0.033 inch on the finish, and requires less than 20 minutes. High-pressure coolant fed through the hollow tool spindle to carry away chips helps achieve the 5 to 8 microinch finish obtained. Remaining bores are done in four setups by manual indexing and clamping on this Heald Bore-Matic.

SPRAYING THE MOLD of a high-pressure gas meter housing with releasing agent assists both metal flow and release. The housing, cast in 356 aluminum alloy, is shaped like a bucket with an integral rib dividing it down the center. Engineers at Oswego Castings Corp. encountered problems in avoiding "holidays" in the finished piece and "misruns" when the rib broke off during extraction. Sprayed with a dispersion of colloidal graphite in water, these difficulties are minimized. A single coating is good for a run of 8 to 10 pieces. Metal flow and parting is improved. The dispersion, Aquadag, is made by Acheson Colloids Co.

TOOLS at work

CASTING ARE HELD for OD machining without distorting the thin wall and without marring the finish-machined ID of a thin-walled casting by using soft aluminum alloy pie jaws. At the DeVelco Corp. plant it was found that soft steel jaws were slippery and that application of pressure for holding caused marring and distortion. Thus only very light cuts were possible. After changeover to aluminum jaws, production increased from 5 pieces per shift to 80 pieces per shift and scrap decreased. The jaws, made by Siewek Tool Co. also lighten the spindle load since aluminum is appreciably lighter than steel.

improving reliability of GROUND PARTS by avoiding residual stress

By James E. Price
Grinding Wheel Institute
Cleveland, Ohio

Residual stresses left by grinding can cause premature failure of parts in service. Research has disclosed ways to avoid setting up these stresses.

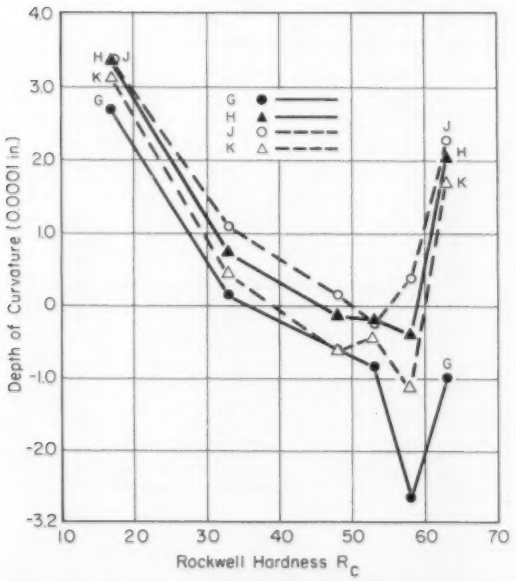


Fig. 1. Effect of wheel grade on curvature perpendicular to traverse for six steel hardnesses.

AIRCRAFT AND MISSILE COMPONENTS that combine maximum strength and minimum weight make new demands of manufacturing engineers—they must be sure that the manufacturing processes used do not cause the part to fail prematurely in service. For example, residual stresses induced in a component by grinding operations can lessen life of the component. Early studies (References 1, 2, 3)* of grinding-induced stress showed the residual stresses to be predominantly tensile and at the surface. Fatigue studies revealed that shot peening eliminated stresses and improved the fatigue life significantly. The studies also indicated that both grinding parameters and coolant influence the type and patterns of stresses. When grinding is done under severe conditions, a reduction in fatigue limit occurs. Grinding under proper control can actually raise the fatigue limit. Additional investigation not previously reported now reveals the existence of more methods for minimizing residual stress in a ground workpiece.

Method of Investigation: To investigate the residual stress induced by grinding, specimens of manganese oil-hardening tool steel were prepared to hardness levels of R_C 12, 31, 47, 54 and 64. Test piece dimensions were approximately 2 x 2 x 0.25 inches. To eliminate edge effects between specimens, they were spaced on a magnetic chuck. Stress was induced by grinding them on a reciprocating table surface grinder.

Amount and kind of stress was determined by a technique known as deflection measurement. Over-all stress can be determined by the measurement of the tendency of a stressed piece to curve either convex or concave. This curvature depends

*References are tabulated at the end of article.

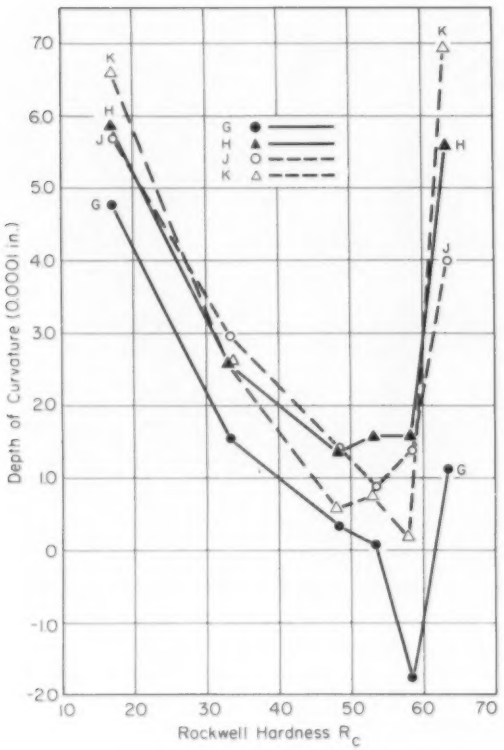


Fig. 2. Effect of wheel grade on curvature parallel to traverse for six steel hardnesses.

on whether the over-all stresses are compressive or tensile. It is pronounced in something as thin as shim stock, but can be measured with precision gages even in 0.25-inch thick pieces. Since the stresses will cause a piece to deflect or bend slightly in one direction or another, it is possible to measure these stresses by etching away the stressed material and measuring changes in curvature. With additional calculations, the measurement of these changes in curvature produces a record of the stress distribution at various levels in the ground part. The details of the curvature measurements and stress calculations are given in Reference 2.

Three series of tests were conducted, examining three variables: wheel grade, steel hardness and grit size. Except as noted, grinding conditions for all tests were: White aluminum oxide wheels, 46 grit, J grade, 8 x 0.5 x 1.25 inches, with vitrified bond were used; wheel speed was 6000 fpm, traverse speed 50 fpm, unit downfeed, 0.001 inch, total downfeed 0.010 inch and coolant was air. To examine effect of wheel grade, four grades (GHJK)

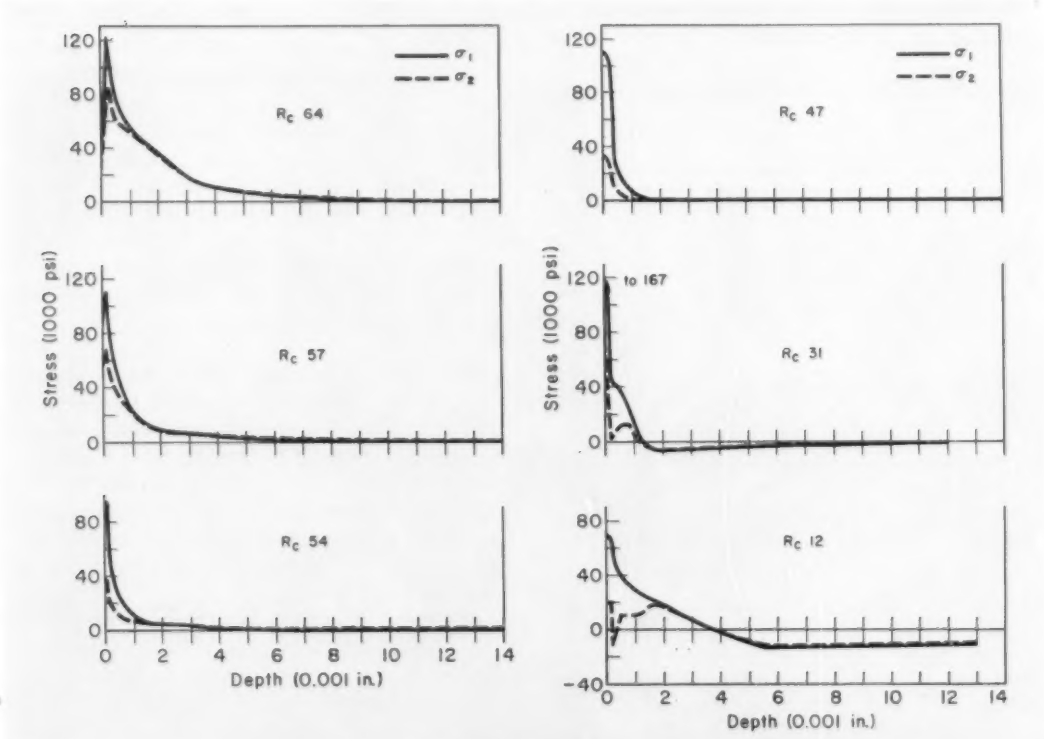


Fig. 3. Effect of steel hardness on residual stress distribution.

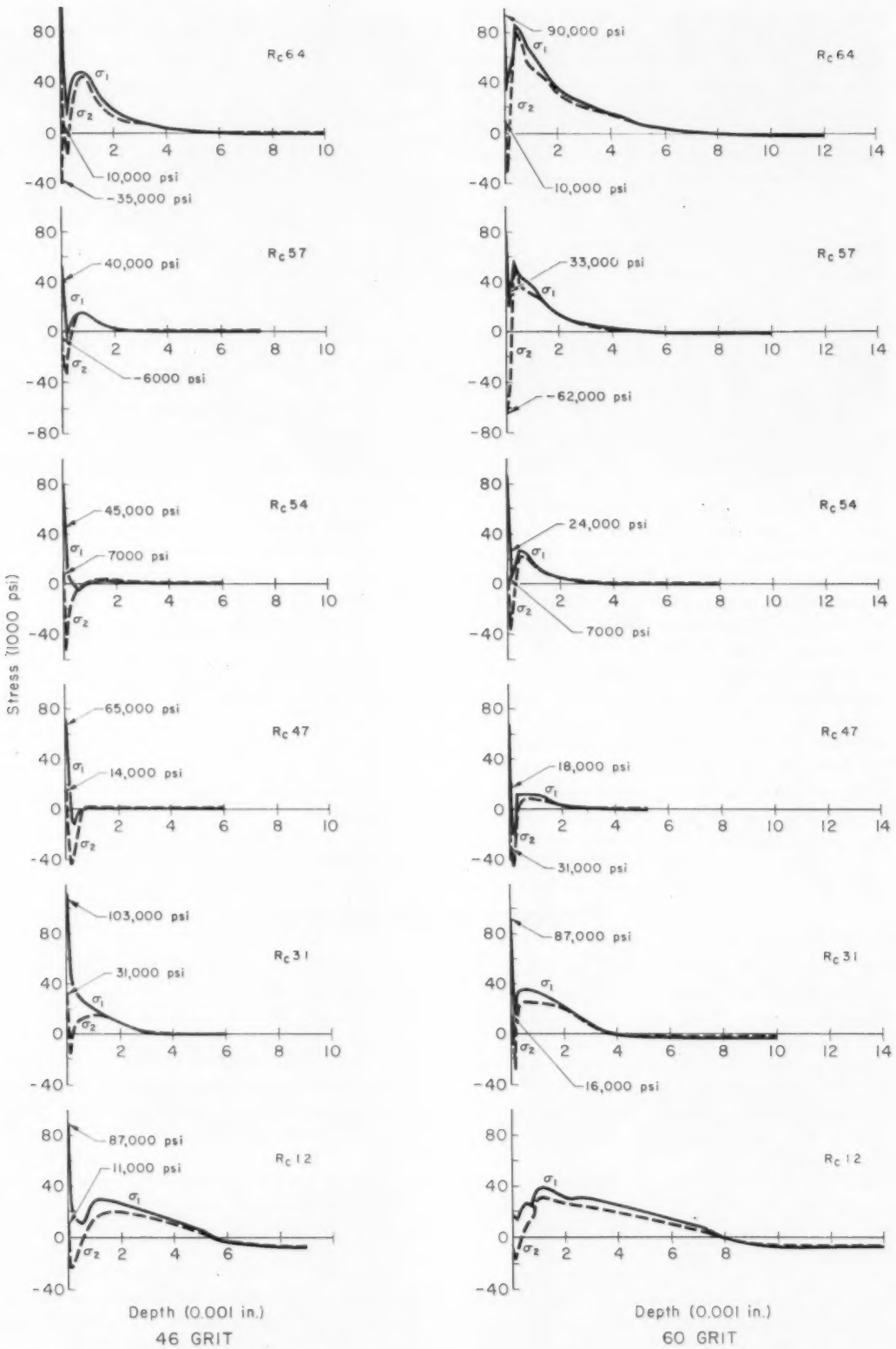


Fig. 4. Comparison of stress distribution obtained with two different grit sizes.

were tried on the six steel hardnesses. Curvatures obtained are shown in *Figs.* 1 and 2. Steel hardness alone was the variable in a set of specimens analyzed for stress distribution, curves for which are shown in *Fig.* 3. The effect of grit size was examined by running a J grade wheel, 60 grit at traverse speed of 60 fpm on a set of six specimens. A total downfeed of 0.015 inch was used as measurements seemed uncertain when a downfeed of 0.010 inch had been reached. The additional 0.005 inch of stock was removed in increments of 0.001 inch per pass. The effect of grit size on residual stress distribution is shown in *Fig.* 4.

Test Results: Changes in wheel grade affected stress less than the differences in steel hardness. For all four grades tested, minimum stress occurred at a hardness level of about R_C 48. This behavior is restricted to the particular steel being tested and is shown as an amount of bending measured for each test condition, *Fig.* 1 and 2. To examine the bending behavior, one set of specimens produced with a J grade wheel was analyzed for residual stress, producing the set of stress distribution curves shown in *Fig.* 3. The stress distribution curves explain over-all curvature differences noted in *Figs.* 1 and 2—minimum depth of stress penetration occurs around R_C 47. At this point there is an apparent reversal in the depth of penetration.

Results of grit size evaluation, *Fig.* 4, show two notable factors. First, there is a general relationship between depth of penetration and hardness. For both grit sizes, minimum depth of penetration occurs at about R_C 47. Second, a comparison of the 46 and 60 grit wheels shows a general tendency for increased average stress and depth of penetration with the 60 grit wheel. This difference is possibly attributable to the fact that the additional 0.005 inch of stock was removed. Measurements had been started on the 60 grit wheel samples when only 0.010 inch had been removed. It was noted that curvatures were appreciably greater when the additional 0.005 inch was removed, indicating perhaps that larger and deeper stresses had been induced in the final cut. Power measurements taken on the 60 grit wheel showed an increase stepwise from the tenth pass to a final increase of approximately 25 percent required on the fifteenth and final pass.

Over-all results indicate that regardless of wheel grit size and grade, minimum curvature occurred at R_C 47 in this particular sample of steel. Further, minimum depth of penetration occurred at R_C 47. Thus, there seems to be a definite hardness factor for a particular steel that will minimize the depth of penetration of grinding stresses. From a practical standpoint, the test principles outlined here can readily be used to determine the point at which the minimum stress occurs. This information can be helpful in avoiding stress and distortion of the component during grinding.

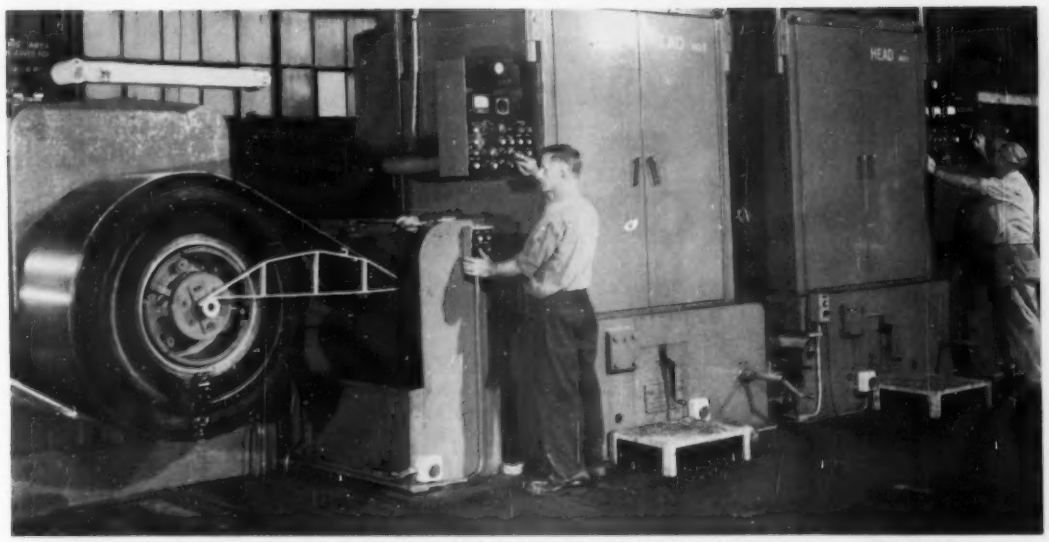
References

1. Tarasov, L. P., W. S. Hyler and H. R. Letner,—"Effect of Grinding Conditions and Resultant Residual Stresses on the Fatigue Strength of Hardened Steel." *Trans. ASTM*, Vol. 57, p. 601-622, 1957.
2. Letner, H. R. and H. J. Snyder,—"Grinding and Lapping Stresses in Manganese Oil-Hardening Tool Steel." *Trans. ASME*, Vol. 75, p. 873-882, 1953.
3. Letner, H. R.—"Residual Grinding Stresses in Hardened Steel." *Trans. ASME*, Vol. 77, p. 1089-1098, 1955.

Progress in Production

A common and vital industrial product, tacks, were among the first products manufactured in the American colonies. Many were hammered out by New England farm families as they sat around the fireside at night. These early tacks and nails were then sold or bartered, sometimes used as money in the currency-short colonies. Yankee farmers presumably have something else to do with their evenings nowadays.

Many of the changes in tack making have been brought about by the W. W. Cross & Co. in Jaffrey, N.H., who have been making tacks since 1869. The plant chews up an average of a boxcar of steel every working day to turn out approximately 1000 kinds and sizes of tacks. After unloading from boxcars, sheets of Tack Plate, a special steel made by Jones & Laughlin Steel Corp., are pickled, washed, lime coated and baked dry. The lime coating acts as a dry lubricant. The sheets are then separated into quarter gages, edges are sheared square, and the sheets cut into narrow strips. Width of the strip is determined by the size and type of the finished tack. Tack Plate strips are loaded into automatic feeding devices on forming machines. These automatic feeding devices, specially designed by Cross, give the machines the appearance and sound of old-fashioned Gatling guns. The tacks are formed, pointed and headed in a rapid-fire series of operations. The ingenious and complicated machines stamp out several hundred tacks a minute from the narrow widths. Since workers in many trades customarily hold tacks in their mouths, these varieties are sterilized in furnaces before being sent to the packaging department. All in all, a considerable change has occurred in New England tack manufacture since tool engineers took over.



Abrasive belt grinding line finishes stainless strip to accuracies required for space vehicles.

BELT GRINDING

. . . assures precision gage of strip

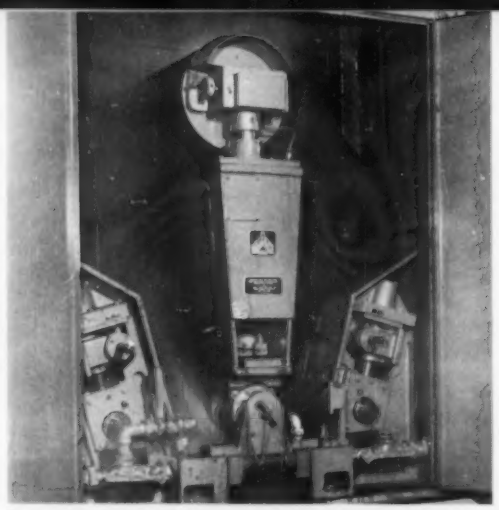
Teamwork and cooperative efforts of machine builder, abrasive supplier and steel mill have developed a production process to produce steel strip within tolerances that had been considered impossible. Those who developed the process described in this article are The Hill Acme Co., Behr-Manning Co. and Wallingford Steel Co.

STAINLESS-STEEL STRIP is now being economically produced to the exacting tolerances required by aircraft, missiles and space vehicles. This close dimensional control has been made possible by the development of abrasive-belt grinders to remove the inherent crown in strip from edge to edge as well as the increasing thickness from the start to the end of a coil. The crown, created from roll deflections, and the increasing strip thickness, caused by progressive cooling of strip during rolling, are removed by the corrective grinding performed as an intermediate operation at the Wallingford Steel Co. plant.

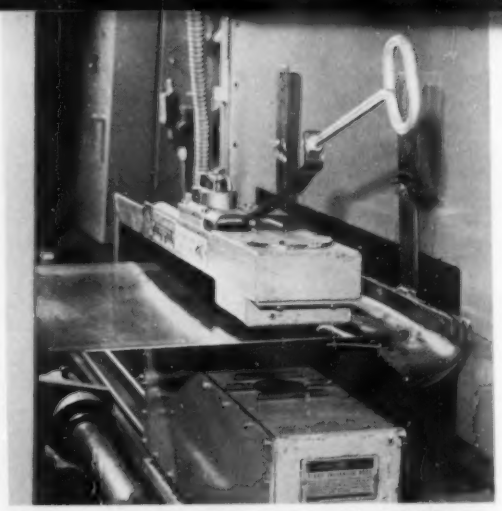
Normally, stainless strip can be produced by this new process within tolerances of 0.0005 inch across the width of 30-inch strip and from end to end of the coil. For close tolerance work, strip has been rolled in this plant within tolerances of 0.000030 inch.

In the process, the crown is ground from the thick strip. Then subsequent rolling operations can be more accurate. If the crown were not removed in early passes, additional rolling passes could not reduce the crown. Instead, it would be relatively accentuated as the gage becomes thinner.

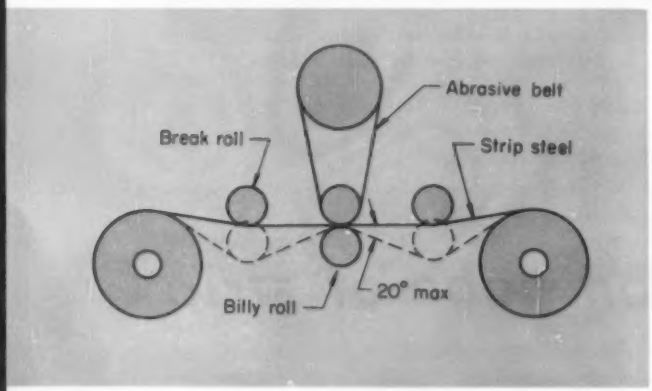
With 1000 pounds tension per inch width of strip each of two 60-hp grinding heads in the system can remove as much as 0.015 inch of stock per pass. Belt speed is 2100 fpm for maximum belt life and line speed is 6 fpm. Finishing passes, however, are run at 20 fpm. Arrangement of the rolls in the grinder is illustrated in the schematic sketch. The strip is sharply bent at angles up to 20 deg by



X-ray gage traverses strip to check thickness at several points across its width. Accuracy of gage detects variations of several millionths of an inch.



Abrasive belt removing crown at speed of 4200 fpm, using knurled steel contact roll. Oil floods grinding head at rate of 65 gpm.



Schematic drawing showing billy roll and break rolls. Break rolls remove tendency of strip to curl or bow.

break rolls arranged both before and after the grinding rolls.

The billy roll or work-support roll is 8 inches in diameter and holds the strip against the abrasive belt by hydraulic pressure. The contact roll is knurled steel for heavy cuts. For light or finish grinding, serrated rubber rolls with 45-deg ribs, ranging from 45 to 90 Durometer hardness, are employed. Dynamically balanced, rolls operate at 900 and 1800 rpm to give the 2100 or 4200 fpm speed required.

Belts for grinding are 30 x 126 inch resin-bonded belts with either aluminum oxide or silicon-carbide abrasives. Grinding is performed with oil, either flood or spray application. The coolant is sulfur-chlorinated oil and lard oil with a viscosity of 190 Saybolt seconds. The sulfur imparts better belt life and minimizes belt loading. The coolant pumped to each grinding head averages about 65 gpm. The maximum flow possible with the pumps is 100 gpm per head. Electrostatic precipitators remove the oil vapor atomized by the abrasive belts.

When close tolerances are desired, one heavy cut and several fine passes are taken on each side of the sheet. To reduce the vertical or normal grinding component during heavy grinds, the feed is slowed down accordingly. This avoids the possibility of crowning the strip during grinding.

Significance of the new process is apparent when production is compared with that of the former method. With the former method, lead time for grinding was four weeks. An average coil required about three passes with a maximum production of two coils per shift. In addition to using four or five belts per strip, the control of gage was not as good as desired. Labor costs proved relatively high and averaged somewhat less than $0.50 a square foot.

With the new system, costs for belts and labor have effected savings amounting to $90,000 on an annual basis. This estimate is based upon processing 1500 tons per month to produce machine-quality strip. Using this production as a basis of comparison, the cost of belts, labor and oil would be $0.175 per foot for the former method and about $0.07 for the new. On a tonnage basis the comparative cost reduction would be from $31.50 to $12.72 per ton. In addition production can be doubled. Savings in prime steel by this method of corrective grinding is considerable.

Did You Notice?

We slipped. Some copies of the November issue were printed with an error on page 81. The formula for B in Robert D. Brown's article on surface roughness should read as follows:

$$B = \sqrt{R^2 - \frac{F}{4}} + \frac{R^2}{F} \sin^{-1} \frac{F}{2R}$$

REFERENCE SHEET

designing HARMONIC CAMS

By Louis H. Harris
Tool Design Supervisor
Wright Machinery Co.
Durham, N. C.

MOST WIDELY USED of all cam curves, the harmonic cam can be produced either by layout techniques or by calculation. In using the layout technique, standard practice is to lay the cam out oversize, up to a ratio of 100:1 to assure that the curve is accurate. Calculation offers distinct advantages—layout erors are eliminated, the points can be machined and inspected accurately and it is generally cheaper to machine points close together than to blend large areas by filing and sanding. Both techniques are described for three examples.

Harmonic Curve: To lay out the harmonic curve, *Fig.* 1, a semicircle whose diameter equals cam throw is drawn perpendicular to a base line representing the cam rotation. The semicircle is divided into n equiangular segments and the base line into the same n number of divisions. From the semicircle, the division points are projected parallel to the base line and from the base line the division points are projected perpendicularly. Intersections of these two lines define the harmonic curve.

Calculating the harmonic curve is easily done using the accompanying table. Cam throw and cam rotation are divided into the same n number of divisions. Harmonic constants for each division are multiplied by total throw to obtain the harmonic proportion of throw occurring at each division. For instance, in *Fig.* 1 where $n=6$, the harmonic constant for the fourth division along the base line is 0.75. If total throw is 0.5 inch, then cam throw at the fourth division point is 0.375 inch. The fact that a harmonic curve's two halves are mirror images simplifies the task; calculation need be done only to the midpoint of the curve, then reversed.

Reciprocating Follower Cam: The method of laying out a simple disk cam for driving a reciprocating follower is shown in *Fig.* 2. A circle is drawn with a radius equal to the dwell. The angles of rise or fall are then marked off and divided into some n number of divisions. To the same scale and with the same n number of divisions a harmonic curve is drawn and harmonic increments from the curve are graphically added to the cam radius for a rise, or subtracted from cam radius for a fall. Fairing between points completes layout of the cam contour. Adding cutter or follower radius to cam radius and listing the radii, as in *Fig.* 2, simplifies the setup for machining the cam.

For generating a similar cam contour by calculation, the angle of rise or fall is divided into some suitable number of increments and the angular dimension of each division successively listed as in *Fig.* 3. Using the table, harmonic increments of rise or fall are calculated for each of the divisions. These harmonic increments are added to the cam center-to-follower center radius and listed opposite the angular dimension. By listing cutter or follower size and providing a few instructions, the data sheets

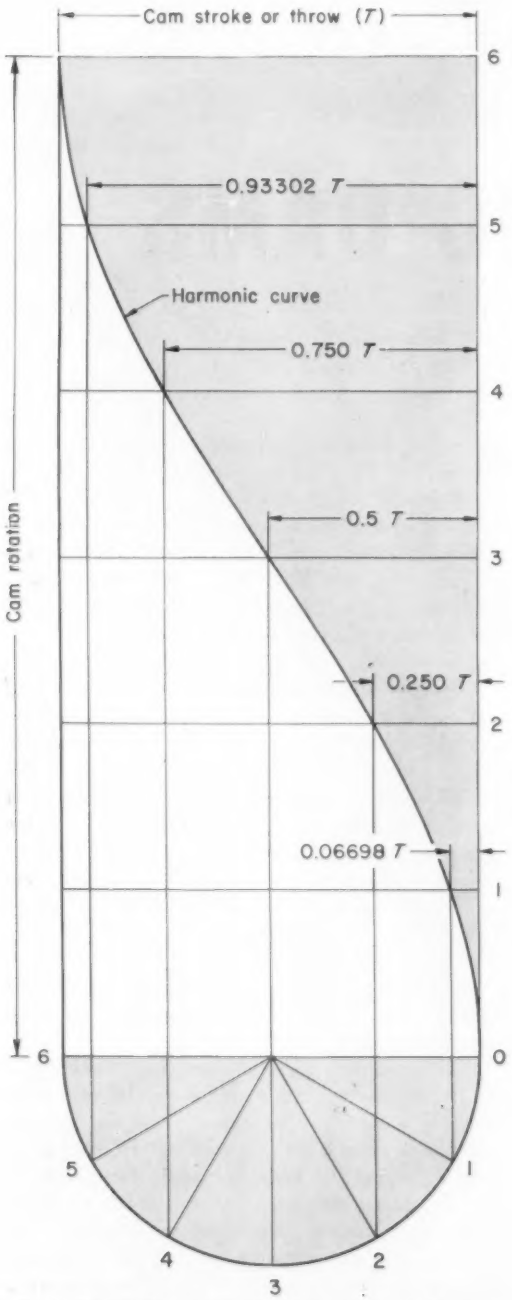


Fig. 1. Harmonic curve used to lay out harmonic cams.

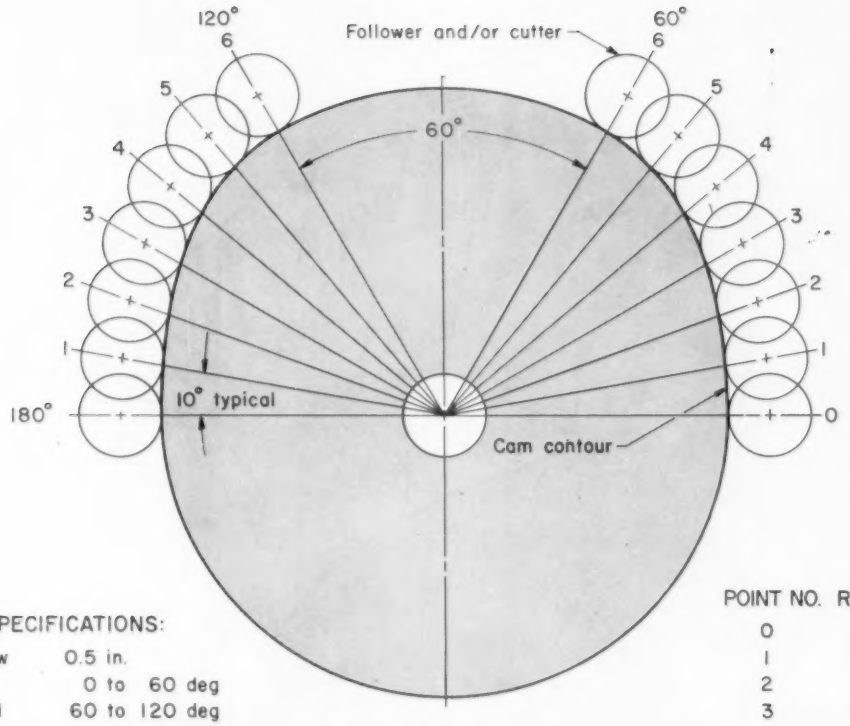
serve for manufacture of the cam in lieu of a drawing. To obtain adequate accuracy in the cam curve, many more points should be calculated than are shown in the example.

Oscillating Follower Cam: When the cam follower is to oscillate through some angle about an offset fulcrum, *Fig.* 4, both layout and calculation are more complex. To lay out such a cam, known geometry is first set down. This usually includes location of the cam center *A*, the fulcrum center *F*,

Table—Harmonic Constants

Number of Constants, *n*							Constant, *k*
10	20	40	80	6	8	12	
			1				0.000385
		1	2				0.00154
			3				0.003465
	1	2	4				0.006155
			5				0.009605
		3	6				0.013815
						1	0.017035
			7				0.01877
1	2	4	8				0.02447
			9				0.030905
		5	10		1		0.03806
			11				0.04593
	3	6	12				0.05449
			13				0.06375
				1		2	0.066985
		7	14				0.07368
			15				0.084265
2	4	8	16				0.09549
			17				0.10734
		9	18				0.119795
			19				0.13284
	5	10	20		2	3	0.146445
			21				0.1606
		11	22				0.175275
			23				0.190455
3	6	12	24				0.206105
			25				0.222215
		13	26				0.23875
				2		4	0.25
			27				0.25569
	7	14	28				0.273005
			29				0.29067
		15	30		3		0.30866
			31				0.32694
4	8	16	32				0.34549
			33				0.36429
						5	0.37059
		17	34				0.383275
			35				0.402455
	9	18	36				0.42178
			37				0.44123
		19	38				0.46077
			39				0.48037
5	10	20	40	3	4	6	0.5

By using $k_{n-1} = (1-k_1)$, $k_{n-2} = (1-k_2)$ and so forth, this table for a half curve applies to the full curve. For example, where $n = 6$, $k_5 = 1-0.066985$ or 0.933015, and k for the fourth of six divisions is 0.75; and so forth.



CAM SPECIFICATIONS:

Throw	0.5 in.
Rise	0 to 60 deg
Dwell	60 to 120 deg
Fall	120 to 180 deg
Low dwell	180 to 360 deg
Follower	1 in. diam

POINT NO.	RADIUS (inch)
0	4.000
1	4.033
2	4.125
3	4.250
4	4.375
5	4.466
6	4.500

Fig. 2. Layout of harmonic disk cam to drive a reciprocating follower.

length of the cam lever L, angle θ and arc CB through which the follower center oscillates and φ, the angle of throw. Layout is as follows:

1. Draw the angle ϕ as a circle segment whose radius is AF. Divide arc EF into n equiangular divisions.
2. Divide chord CB (the cam throw) into n harmonic divisions and project the divisions to intersect arc CB. These intersect points establish the successive cam center-to-follower center radii for a harmonic throw as the cam rotates through angle ϕ.
3. Arcs with radius L are swung from the division points previously marked on arc EF. These arcs intersect the harmonic radii to indicate successive cam center locations. From the follower center-points, arcs are drawn to represent the follower. A curve faired tangent to successive follower peripheries is the desired profile.

To calculate the same cam profile, the following steps are used:

1. From known dimensions the angle β is found by triangulation, *Fig.* 5.
2. The angle of oscillation θ is divided harmonically so that θ is composed of $\theta_1 \ldots \theta_n$ angles whose values can be determined from the table. For example, if θ is divided into 6 harmonic increments, then $\theta_1 = (0.06698)\ \theta$, $\theta_2 = (0.25)\ \theta$, and so forth. Each of the θ_n angles is bounded on one

CAM MACHINING DATA SHEET

Cam Type RECIPR.		Part No. 3338
Point No.	Angular Setting (degree)	Radius to Cutter Center (inch)
0	0	4.000
1	10	4.033
2	20	4.125
3	30	4.250
4	40	4.375
5	50	4.455
6	60	4.500
7	120	4.500
8	130	4.466
9	140	4.375
10	150	4.250
11	160	4.125
12	170	4.033
13	180	4.000
14	360	4.000

Fig. 3. Complete cam manufacturing information can be listed on a data sheet.

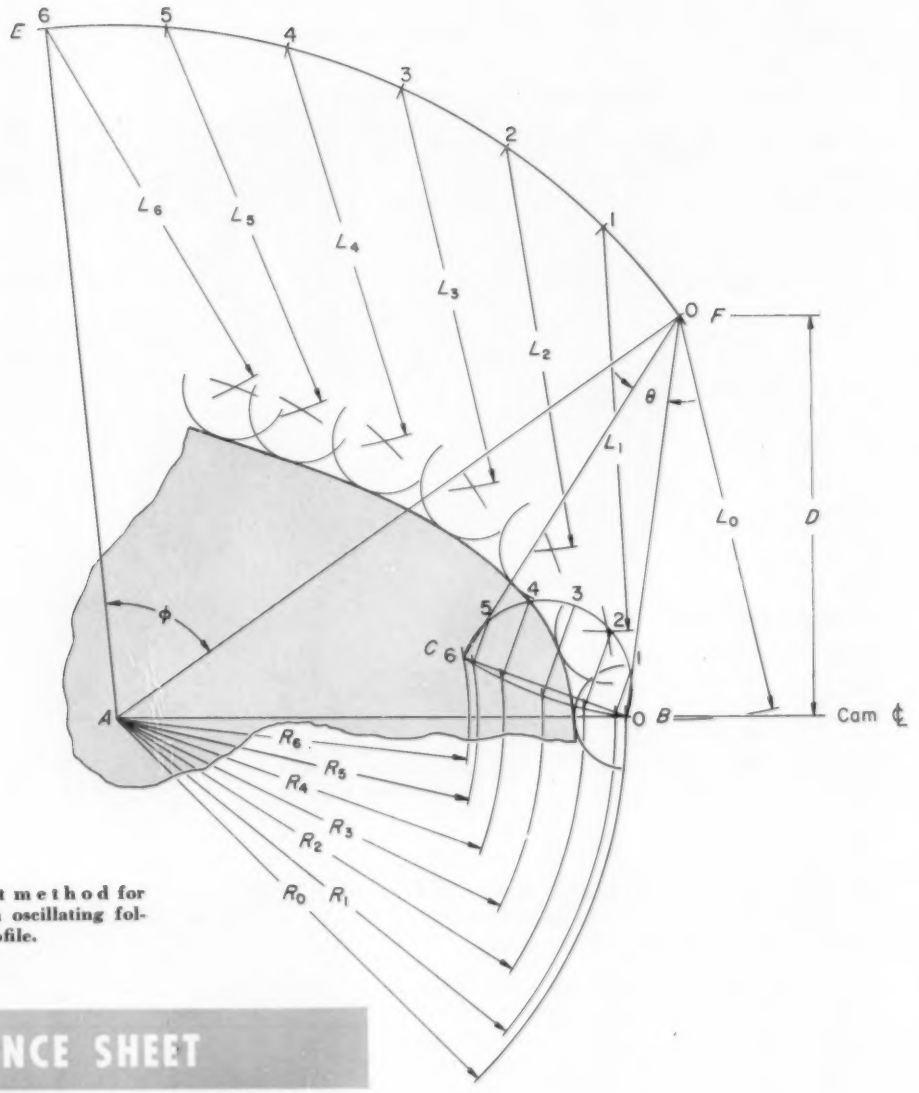


Fig. 4. Layout method for generating an oscillating follower cam profile.

REFERENCE SHEET

side by a line *FP* that intersects arc *CB* at some point *P*. A line drawn from *P* to *A* forms a triangle that can be solved for the length *AP* and angle β_1. In a similar fashion, *n* triangles are solved for $AP_1 \ldots . AP_n$, the cam center-to-follower center radii, and $\beta_1 \ldots . \beta_n$.

3. For the angular coordinate of each successive radius, increments of β must be added to increments of φ. This is because the follower moves β degrees relative to the cam center while the cam rotates φ degrees, so that total angular movement is $\phi + \beta$. The values previously obtained for angles $\beta_1 \ldots . \beta_n$ are added to the change in φ to determine total angular movement for each increment of rotation. This can be expressed $\phi_x + \beta_x = x\phi/n + \beta_x$, where *x* is any of the selected divisions and *n* is the total number of divisions.

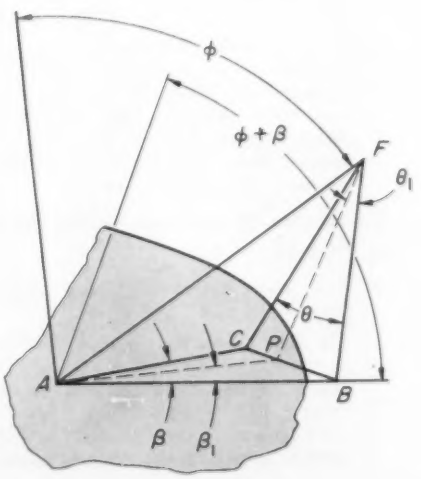


Fig. 5. Geometry used in calculating an oscillating follower cam profile.

news

"It isn't what you pay per hour that counts—it's what you get per hour."

See Page 95, From Prof to Pro

astme in action

news section

features

Numerical Control Invades the Southwest 87

National Seminars Invade the South 89

Die Design Handbook Published in Polish 90

Heart of Gold Has Silver Lining 91

Wartime President of Society Dies 92

Members in the News 93

From Prof to Pro 95

Chapter News 98

chapters

Baltimore 100
Binghamton 100
Chattanooga 100
Danbury 98
Detroit 99
Framingham 101
Golden Gate 103
Greater New York 100
Hartford 101
Houston 87
Ithaca 100
Kalamazoo 100
Lansing 100
Long Island 102
Madison 101
Mansfield 100
Montreal 102
Peoria 103
Racine 91
Rochester 99
Santa Monica Bay Area 103
South Bend 102
Springfield (Ohio) 100
Sydney 100
Utah State University 98

Numerical Control Invades the Southwest...

IN AN ATTEMPT to encourage production tolerances of 0.0005 inch in a state where most everything is at least a yard long and a mile wide, the Houston chapter of ASTME recently sponsored a two-day, one-night symposium on numerical control.

It was a case, one Texan declared, of learning to think small by thinking big. He and some 70 other tool and manufacturing engineers from the Houston area enthusiastically accepted the challenge.

They were told that the advent of numerical control devices in Houston (there's already one on a production line, firm commitments for several others) would without doubt lead to revolutionary change and diversification of the city's industrial character. Nationwide, one expert said, numerical control should open up a whole new vista of individual enterprise and opportunity for both large and small manufacturing concerns.

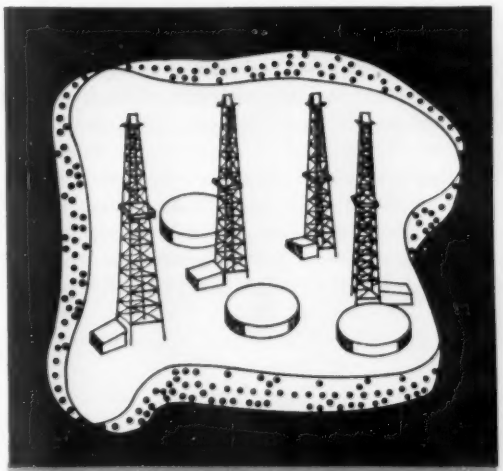
Diversification is admittedly needed in Texas, where conservation laws have cut back oil production—the No. 1 industry—to an eight-days-a-month pumping schedule currently. The state accounts for 41 percent of oil production in the United States.

Decentralization Called Inevitable

"It is senseless," said Chief Engineer Wally Brainard of Kearney & Trecker Corp., Milwaukee, "to ship completely manufactured products such as washing machines to all parts of the country. Instead, we should be shipping raw materials to diversified industries. Numerical control of tooling machines is making this possible. Decentralization is inevitable."

In addition to the regular registrants and 20 eavesdropping students from the University of Houston at the day sessions, almost a hundred more persons—most of them being invited executives from Houston plants—turned out for a steak dinner and numerically controlled dessert. In a new approach to on-campus conferences of this sort, the Houston chapter brought all the symposium speakers to the downtown dinner and had them give capsule renditions of what they had dished out during the day. The capsules, however, along with the questions and answers they prompted, presented the numerical control concept from the top-management point of view.

A typical comment after the executive program came from John A. Grundy, vice president of production at Reed Roller Bit Co.: "We at our company had felt that numerical control was not adaptable to the oil tool industry. However, these experts have given us confidence that numerical



...the Southwest

control is adaptable to the needs of Reed and its subsidiaries, Cleco Div. and Electro Dynamics Instrument Corp."

The experts he referred to, besides Brainard, were four men from the Bendix Corp. and two from the Boeing Applied Computer Service at Wichita, Kan. All of them might be called old-timers in a field that has only a four-year history.

Another who could qualify as an expert by virtue of numerical control pioneering at his own plant in Houston was Chief Engineer Irvin K. (Ike) Fussell of Schlumberger Well Surveying Corp., who was general chairman of the symposium. Tom M. Nelms, chapter program cochairman and president of Wessendorff, Nelms and Co., moderated the sessions. Day and night activities were coordinated by Ernie A. Prochaska of Hughes Tool Co.

Control by the Numbers

The first speaker, Edward J. Strong, southwestern regional manager of Bendix' Industrial Control Section, defined numerical control as simply "control by the numbers"—wherein numerical values are converted into physical values which produce motions on the machine tool. Of approximately 150 continuous path numerically controlled production machines in the country (most of them Government-owned or subsidized), Strong said 15 were already operating in the Southwest and 22 to 27 more were on firm or tentative order. There were only six such units in the area at the beginning of the year, he added.

"Economics of Numerical Control" was discussed by W. D. Geist, for 19 years a Boeing engineer and since early this year the director of sales for the firm's Applied Computing Service. Geist said Boeing's experience had been that numerical control cut the shop rate from $12 to $4 per hour, cut material handling costs by 30 percent, materially reduced setups and lead time, trimmed inventories sharply with the shortened flow-time through the shop, and improved productivity by an 11.7:1 ratio.

"Most of our uses of numerical control in metalworking are applicable in other than the aircraft field," Geist declared. "Our rule of thumb on lot sizes is three parts, but numerical control can sometimes be justified even on lot sizes of one part." Long-range plans, he added, are for the Wichita facilities to have no conventional machine in the shop five years from now.

Warning Against Hasty Marriage

Brainard, in his talk on "Product Design and Numerical Control," contended that numerically controlled machines not only favor product flexibility, closer tolerances, short runs and complex jobs, but significantly enable quick adoption of competitors' advancements in product design. However, he cautioned against the hasty mating of controls with existing machines that cannot meet the quality and rigidity standards demanded by this method of manufacturing.

"Numerical control's flexibility should be a boon for communities—such as Houston—outside the concentrated manufacturing centers," Brainard said. "It should enable them to compete, even in the consumer products field, with old established firms." He cited the example of a group of West Coast youngsters who recently set up a job shop with a numerical control machine and made a substantial profit from the start.

Programming, tape formats, technical aspects of systems for control and functions of the control units in numerical control were discussed by Jack Moorhead of Boeing; H. H. Schatz, manager of computer programming at Bendix in Detroit; and Jay Gorham, also of Bendix-Detroit. Among the points they made:

- Any known machining problem that can be defined mathematically can be programmed for numerical control.
- Programmers can be taught in about 160 hours.
- Of the three types of tape—punched plastic, paper and magnetic—plastic is most satisfactory because of its permanence and ease of storage.
- The cheapest computer you can get is the biggest one you can keep busy. If you can't keep one busy, buy your programming service.

Pete H. Wormell, manager of the Manufacturing Capabilities Administrative Section for Bendix in Kansas City, talked on implementation of numerical control, stressing the necessity of policy level evaluation and decisions before a firm enters the field.

Labor Pains Before Delivery

"Getting numerical control is like childbirth," said Wormell, who did pioneer work in numerical control for the Atomic Energy Commission. "There's a lot of labor necessary before the delivery. And there may be a lot of expense coming up later for the parents."

The consensus seemed to be that numerical control is truly the "second industrial revolution" which will help eliminate mental drudgery just as the first industrial revolution helped eliminate physical drudgery.

At the conclusion of the symposium, Fussell estimated that 40 to 50 percent of the dollar value of new investments by Houston industry in the next five years would be in numerical control devices.

National Seminars Invade the South . . .

IN AN ATTEMPT to help the deep South mint some industrial prosperity along with its juleps, ASTME has scheduled a Creative Manufacturing Seminar in Atlanta on Dec. 7-8.

The National Education Committee's seminar, titled "Metalcutting Today," will be the first such national Society program in Dixie. Cosponsored by the Atlanta chapter, the sessions will be held in the Dinkler Plaza Hotel. Chairman will be a national vice president of the Society, Frank F. Ford, who is head of the Ford Supply Co. in Atlanta.

The Atlanta session will be the second of this year's series of nine Creative Manufacturing Seminars. The first, on "High Energy Rate Forming," was presented to 85 persons at Chicago in mid-October.

The Southland's rapid strides toward industrialization and surging interest in metalworking prompted NEC to select the fundamental subject of metalcutting for its invasion of the Atlanta area. Thirteen papers will explore in detail the latest improvements, techniques and ideas in this basic phase of the metalworking industry. Among the speakers will be Dr. Alfred O. Schmidt, chief research engineer at Kearney & Trecker Corp., lecturing on "Machinability, New Developments, and Research Progress"; Jens L. Wennberg, senior research engineer at The Cincinnati Milling Machine Co., speaking on "Economics of Metalcutting"; and Colin Sharp, director of the R&D laboratory at Brown & Sharpe Mfg. Co., on "Production Milling with Precision." Other papers will cover steel, carbide and ceramic cutting tools; cutting fluids, grinding, broaching and broach design, and drilling and drill design.

Papers to Feature Exotic Metalcutting

Of special interest will be three papers comparing and contrasting the conventional chip-making processes with the so-called exotic techniques of electron beam, ultrasonics and electrical discharge machining.

Moderating the metalcutting forum on the last day will be Jack Case, superintendent of the Mechanical Operations Div., Union Carbide Nuclear Co., Oak Ridge, Tenn., and Sidney B. Jeffreys, owner of Jeffreys Engr. Equipment at Greensboro, N.C. Case is a member of Knoxville-Oak Ridge chapter, Jeffreys of Piedmont chapter.

Paying concentrated attention to the problems encountered by manufacturing people in working the new metals and superalloys will be a seminar Jan. 18-19 in Dallas' Statler Hilton Hotel on "Machining and Forming Space-Age Metals." North Texas chapter, representing ASTME members in the Dallas-Fort Worth area, will be cosponsor with the National Education Committee. More than a dozen papers will cover explosive forming and cutting, milling and drilling high-strength steels, chemical milling and plasma arc techniques, E.D.M. of superalloys, machining beryllium, machining and forming titanium and its alloys, and—perhaps newest of all—magnetic forming.

The first seminar of the new year, however, will be one on "Quality Control" on Jan. 11-12 at the

. . . the South

Chase-Park Plaza Hotel, St. Louis. Cosponsored by NEC, St. Louis chapter of ASTME and the American Society of Quality Control, this seminar will cover recent developments in master gages, air gaging, electronics, optics, instrumentation, radioisotopes and numerically controlled techniques.

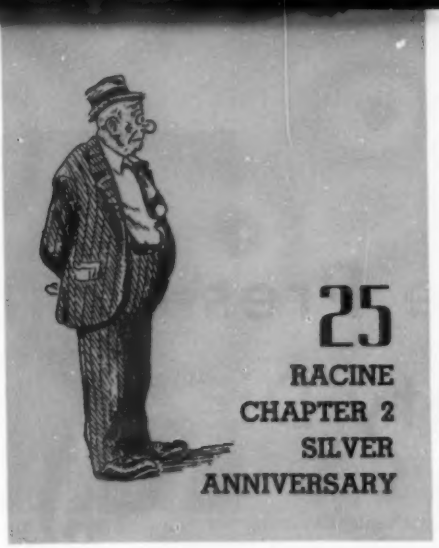
The first Society-sponsored seminar on high energy rate forming—HERF, for short—drew 85 persons to the two-day sessions in Chicago Oct. 11-12. Sixty percent of the registrants were nonmembers of ASTME, attesting to the growing acceptance of the Creative Manufacturing Seminars as the best way to catch up with the going-like-'60 progress of metalworking technology. Of the registrants, fully a score came in from both east and west extremities of the nation, the rest from scattered industrial centers in the United States and Canada. Many were recognized experts in the field.

Popularity of the HERF sessions augurs well for a similar seminar planned in Philadelphia next March 29-30, according to National Education Director Gilbert E. Seeley. But Seeley added that the Philadelphia program will not be a duplication of the Chicago seminar; rather it will complement the material presented there, with different papers presented by different people on different facets of the same subject.

Fees for the seminars have been lowered this year by the National Education Committee to $45 for members, $60 for nonmembers. This includes registration, seminar briefcase and a complete set of the papers presented, and all luncheon tickets.

Die Design Handbook Published in Polish

A Headquarters staff member, who candidly admits he has a hard enough time coping with the English-language edition of the *Die Design Handbook*, takes a chin-scratching look at a Polish version of the Society book. The newest addition to the ASTME's library at Headquarters was printed in Warsaw. But global demand for the book extends beyond Poland. A contract has been signed for a Spanish-language edition of the popular Handbook in Argentina, and the feasibility of a German edition is being studied.



Heart of Gold has Silver Lining

BULL OF THE WOODS, crotchety cartoon character created by the late J. R. Williams, has colored the covers of Racine chapter's monthly bulletins for years. Beneath the Bull's rough exterior, however, everybody knows there lurks a heart of gold. In addition, everybody in Racine knows very well that the ASTME chapter also has a heart of gold beneath its BULLetin covers. . . .

The Wisconsin Community of 90,000 paid tribute recently to the chapter's quarter-century of civic and industrial contributions. Mayor Jack Humble proclaimed Tool and Manufacturing Engineers Week. And, in a speech to 230 tool and manufacturing engineers and their wives, he recognized the fact that the chapter's heart of gold has a silver lining. The chapter members have contributed more than any other group, he declared, to the industrial magic which produces the world-famed products labeled "Made in Racine."

Besides, it was Racine chapter's silver anniversary.

Climaxing the week was a hospitable shindig on Oct. 21, exactly 25 years after the night in 1935 that the Society's second chapter received its charter. Attending the 1960 party were three of the thirty charter members: Herbert Falkenrath, LeRoy E. Phelps and Cal J. Schweitzer. Two other active charter members, Emil Schneebeli and Floyd J. Lucas, could not be present at the affair.

Also among the 230 at the dinner were the mayor; the Society's President H. Dale Long and his wife; and Dr. Neal Bowman, staff speaker of the National Association of Manufacturers. Both the mayor and Long voiced a challenge for Racine tool engineers to help meet the growing specter of foreign economic competition. Dr. Bowman regaled his Racine audience with a discussion of most everything but "Pitfalls of Economic Illiteracy," the title of his talk.

President Long noted especially the Racine chapter's pioneer efforts to help junior engineers. A program is now underway to funnel this help through support of JETS—Junior Engineering Technical Society. In its college-level scholarship contributions, the chapter has aided several students at the University of Wisconsin and has carried two of them through to graduation in mechanical engineering. The current scholarship program has been increased until it now supports students at the Madison institution.

Chapter officers who planned the anniversary celebration are Chairman John W. Kellogg; Raymond E. Knapp, first vice chairman; Art McCallum, second vice chairman; Don Freres, secretary; Bernard Matter, treasurer; and the Program Committee under Chairman Robert G. Welch.

Racine was the first chapter to be chartered outside Detroit. Its membership is 272—or 273, counting the Bull of the Woods!—*Paul R. Tiles.*

Cal J. Schweitzer, master mechanic of Twin Disc Clutch Co., is one of five charter members who remain on Racine chapter's active list. Originally there were 30. Now chapter historian, Cal was instrumental in organizing Racine chapter.

Racine Chairman John Kellogg and Vice Chairman Ray Knapp watch as Mayor Jack Humble signs the official proclamation of Tool and Manufacturing Engineers Week in Racine. The mayor delivered the opening remarks at the chapter's silver anniversary celebration.

Frank W. Curtis

Wartime President of Society Dies

FRANK W. CURTIS, 65, a past national president of the Society and the "father" of the Executive Night meetings that have become traditional in many ASTME chapters, died Oct. 17 at his home in Sarasota, Fla. Nationally known as an expert on induction and dielectric heating, he had retired in August 1956.

No one but Frank Curtis himself was surprised when he was chosen to head the Society in 1941. As he said at the time, "Although I had been active in ASTE for a number of years, my election to the presidency came out of a clear sky."

Achievements, however, justified selection of the "dark horse." He had been on the Board of Directors; he had taken part in the organization of both Pittsburgh and Springfield (Mass.) chapters, serving as chapter chairman at Springfield; he had served meritoriously on national committees.

Crusader for Better Chapter Programs

And he had especially surged to the forefront in Society members' eyes because of his crusade for better chapter-level programs. An example of this crusade was the first Executive Night in ASTE annals, in Curtis' home chapter of Springfield, while he was chairman, in December 1940. That meeting set the precedent for the Society's close relationship with industrial management.

A few months after he took office as national president, Curtis assumed even heavier responsibilities when the Society's Executive Secretary Ford R. Lamb fell ill and soon died. In the interim before Lamb's post was filled the following March, Curtis and his assisting officers—including Vice Presidents Otto W. Winter and Ray H. Morris—directed the operations at National Headquarters. This came at a time when the tooling-up for the war effort was causing an upsurge in Society membership and in the complexities of Society stewardship.

Indicative of the times, and of the resourcefulness of the man who was dealing with them, was Curtis' chartering of the San Diego chapter while he was president. He went there to find well over 150 applicants clamoring for charter membership. Because many of them were working wartime night shifts, Curtis set up the charter meeting in two sessions—one at high noon and the other in the evening—and provided for election of officers by carrying over the noon results to the evening.

Despite what Curtis later referred to as the "ton of bricks" aspects of his presidential term, he made it plain in a letter to this magazine in 1946 that ". . .you know, I wouldn't take that year out of my life for any ten."

Curtis, a former editor and experienced author, capped 25 years of active service to the organization by serving for eight years on the National Books Committee (now called National Technical Publications Committee), leaving the group in 1952. More than any one person, he was responsible for the planning of the first edition of the *Tool Engineers Handbook*.

He was currently listed as an advisory member of the National Honor Awards Committee. His work in this committee's recent revision of the Honor Award plaques will be long remembered.

Born in 1895 in Buenos Aires, Argentina, Curtis was a direct descendant of Sir Walter Scott and of Francis Lewis, a signer of the Declaration of Independence. Curtis was an engineering graduate of the University of Missouri.

At his retirement he was branch manager of Morris Twist Drill Co., Detroit. Other business affiliations had included Firth Sterling Steel Co., McKeesport, Pa.; Kearney & Trecker, Milwaukee; P. R. Mallory & Co., Indianapolis; McGraw-Hill Publishing Co., which he served as western editor of *American Machinist* magazine; Haynes Stellite Co. and Dowd Engineering Co., New York; Ford Motor Co., Detroit; and Van Norman Machine Tool Co., Springfield, Mass., where he was for several years chief engineer of the machine tool division.

Survivors include his wife Lois of Sarasota; two sons, Frank Waldo Curtis III of Springfield and Dudley L. Curtis of Florence, Italy; and two daughters, Mrs. Catherine Emerson of Island Falls, Me., and Mrs. Winifred Corbin of Springfield.

J. M. Rudel

Members in the News

Canadian Fairbanks-Morse Co., Ltd., and Rudel Machinery Co., Ltd., of Canada have merged, according to a joint announcement by JOHN M. RUDEL and Robert Morse, III, presidents of the two organizations. The merger creates the largest machine tool distributorship in Canada, declared Rudel. A member and past chairman of Montreal ASTME chapter, Rudel will become a vice president and director of the new company and will be responsible for the machine tool and materials handling activities. He is a past president of the Canadian Machine Tool Dealers Association and a former director of the American Machine Tool Distributors Association, of which he has recently been elected president for the coming year. The company will continue under its present management and policies as a separate autonomous subsidiary of Canadian Fairbanks-Morse with the addition of F-M lines of machine tools and other related equipment.

Having served as assistant executive secretary of the National Tool & Die Manufacturers Association, Cleveland, CHARLES R. BENDER, member of Cleveland chapter, has been appointed executive secretary. Bender joined the association in 1953 after having served as managing director of chambers of commerce in Ohio and Indiana. He will be in charge of the NTDMA office and operations.

WALTER W. HASKINS, Chicago, was recently elected a director of the L. S. Starrett Co., Athol, Mass. Haskins has been associated with the company in various sales capacities for 33 years. He is presently serving as western sales manager and manager of the company's Chicago branch office.

CLYDE FANNING, vice chairman of ASTME's National Standards Committee and member of Saginaw Valley chapter, who has held the post of assistant chairman of the engineering shops at General Motors Institute since 1926, has been promoted to chairman of the shops, succeeding Francis L. Mackin. Fanning will act as consultant on special assignments.

Announcement has been made by Buhr Machine Tool Co. of the appointment of HENRY C. DAUM,

Charles R. Bender

Walter W. Haskins

Clyde Fanning

Henry C. Daum

Detroit, to vice president in charge of sales. Daum came to Buhr from Ford Motor Co., where he served as manager in the manufacturing engineering office.

Norton Co. has announced the transfer of FRANK W. NOWELL, Schenectady, formerly abrasive engineer in the upper New York state area, to a similar post in Chicago. . . . FRANK CHUDOBA, Chicago chapter, has been appointed machine tool coordinator of The Goss Co., a division of Miehle-Goss-Dexter, Inc. Chudoba has been associated with the parent firm in different Rockford plants for the past six years as a methods engineer. Prior to that time he worked for the Electro-Motive Div. as tool engineer. . . . Butterfield Div. of Union Twist Drill Co., with headquarters in Chicago, has announced the appointment of DONALD JACOBSEN, member of Chicago chapter, as sales engineer in that area.

NEUMAN G. REQUE, treasurer of Fond du Lac chapter, is being sent to Brazil by the Transmission and Axle Div. of the Rockwell Standard Corp. of Oshkosh. ELMER E. CROISANT, Fond du Lac member since 1945, was unanimously elected to the ASTME office vacated by Reque for the balance of the fiscal year. Croisant also is with the Rockwell Co.

Appointment of WILLIAM F. MARTIN of Chicago chapter as vice president and assistant general manager of the Mechanics Universal Joint Div. of Borg-Warner Corp. has been announced. Martin became associated with Borg-Warner in July 1956, coming from General Motors Corp., where he was employed for 14 years. He joined B-W's Byron Jackson Div. as manufacturing manager, and by December 1959 had become director of manufacturing services for the parent corporation.

MAURICE L. SMITH, who has been with General Electric, Detroit, for 11 years, has been appointed advertising and sales promotion manager of GE's Metallurgical Products Dept.

Firth Sterling, Inc., announces the promotion of JOHN J. SOWKO, Pittsburgh, to sales manager, product development, carbide division. Sowko, who joined Firth Sterling 19 years ago in the carbide sales division, has served in various capacities from cost estimating to office manager in Chicago, and field sales in Pittsburgh area. . . . GEORGE CARVALHO, Hartford, and JOSEPH BRESCIA, Boston, have been promoted from general managers of machine tool and tap subsidiaries to corporate vice presidents of the Jarvis Corp., Middletown, Conn. . . . Wesson Co., Ferndale, Mich., has appointed PETER G. MINIER, Central Pennsylvania, as service engineer. Minier, who has had five years' experience grinding and making special tools and five years as a manufacturing process trouble shooter, will work in industrial plants throughout the Wesson eastern district.

Eaton Mfg. Co. has announced the appointment of STANLEY J. ROC, Cleveland, as an industrial engineer, after long association with Thompson-Ramo-Wooldridge, and Pesco Products in Cleveland; Gougler Machine Co., Kent, Ohio; and Oilwell Supply Div. of U. S. Steel at Oil City, Pa. . . . Under a regrouping of plants in the Power Train Group of Chrysler Corp., R. A. MCCARROLL, Detroit chapter, has been moved from general manager, engine plants, to staff responsibilities within the power train group.

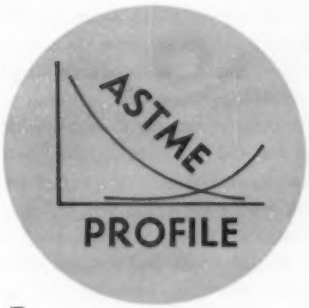
positions available

MANUFACTURING ENGINEER—Opportunity for graduate mechanical, electrical or industrial engineer with two to five years' experience to demonstrate business and engineering ability. Duties include tooling, time standards, product and process improvement, and procurement. Send resume including salary to: General Electric Co., Automatic Blanket and Fan Dept., Bldg. 23 C- West, 1285 Boston Ave., Bridgeport 2, Conn.

METALCUTTING TOOL SALES ENGINEER—For a nationally known company located in Detroit; maker of quality tools for 25 years. One for 45 counties in Northern and Eastern Illinois, and another for Western Pennsylvania and the state of West Virginia. Exclusive territories and straight commission. State background and lines now representing in first letter. Apply to Classified Ads, Dept. 193, 10700 Puritan Ave., Detroit 38, Mich.

MANUFACTURERS AGENTS — Diamond wheel manufacturer requires active and progressive representation; several choice territories available; products include resinoid and metal bonded wheels, also wheels for electrolytic grinding. All products fully guaranteed. Write Diacraft, Inc., 26538 West Seven Mile Rd., Detroit 40, Mich.

MECHANICAL OR TOOL ENGINEER — wanted with B.S., M.E. or equivalent. Leading manufacturer of laminated plastics has excellent opportunity for experienced engineer qualified to assume responsibility for product design, and manufacturing methods. Modern plant, located in eastern Pennsylvania. Good living conditions. Send complete resume, references and salary requirements. Write to Classified Ads, Dept. 192, 10700 Puritan Ave., Detroit 38, Mich.



From Prof to Pro

By M. L. Stone
News Editor

INTESTINAL FORTITUDE is a professorial term for guts.

When Dr. W. W. Gilbert turned his back on a distinguished career as a university professor six years ago, moved to a new community, took on a new job in industry and started putting his classroom theories into competitive practice, that took intestinal fortitude.

But with people in his adopted community of Schenectady, it was guts.

In fact, Schenectady capitalizes on such character traits among its citizenry. They have formed an organization called GUTS, Inc., meaning Gear Up for Tomorrow in Schenectady. Hardly professorial, but practical.

Citizens like Dr. Gilbert are foremost among what GUTS proudly labels its "150,000 people with a purpose." He exemplifies the community aim, which is to make Schenectady second to no other in the nation in the productivity of its working people. Through efforts of such as he, the talent-rich but industry-hungry town of Schenectady hopes to prove to other industries that "it isn't what you pay per hour that counts—it's what you get per hour."

When asked about his own social consciousness, Gilbert might well rejoin that what's good for General Electric is good for the community. His personal aim is to make GE second to no other in the nation in productivity. As manager of the Machining Development Laboratory of GE's Manufacturing Services department, he is in a strategic spot to do just that.

Gilbert is responsible for the development and application, on a company-wide basis, of new machining technology. Since he joined GE in 1954 he has developed a nationally known machinability program based on a scientific approach but tailored for practical plant application. His current concern is the application of machine tools with numerically programmed controls.

"If we can just get people to apply the knowledge that is now available, it will be a real breakthrough," he declares.

He and his top aide, Phil Visser, first vice chairman of the Schenectady ASTME chapter, claim that their scientific approach is reducing machining expense from a half to an eighth of the cost when using conventional and operated machine tools.

"We found early in this program," Gilbert says, "that actual metalcutting time and expense are only about a third of the total machining problem. The other two-thirds is machine operation setup and planning. So we've concentrated on the two-thirds —we spread the gospel of 'Hi-E' (high efficiency) through seminars on machine attachments, optical machine tool alignment, and the use of numerical programmed controls and computerized programming."

High-Altitude Conversation

Gilbert is a serious man; a ready smile is often at odds with the gray-brown intensity of his eyes, and people know him before they call him Bill. Perhaps stemming from his birth 51 years ago in Greeley, Colo., and from his graduation as a mechanical engineer from the state university in Boulder, his conversation is apt to be high-altitude.

Recently he was asked some questions during an unprogrammed conversation, and he answered them with characteristic fortitude. The scene was his cellblock in Building 69 of the vast complex at Schenectady that old GE hands refer to as "Sing Sing."

Q. Why did you quit your teaching career at the University of Michigan, Bill?

A. I wanted to turn pro—to test out some of the theories I'd been expounding in classrooms since I took my doctorate in M.E. in 1935.

Q. What, if anything, is wrong with U. S. engineering education these days?

A. There's not enough of it.

Many U.S. schools have been influenced by the need for scientists into changing their curricula into basic science programs, at the expense of engineering and manufacturing training. The pendulum has already swung too far toward the elimination of programs for the application of engineering knowledge. Since the economy of this country is based upon economic production, and two-thirds of the

A handy man with the chalk, Dr. W. W. Gilbert draws the line on excessive costs during a blackboard session in his "classroom" at the General Electric Co. in Schenectady. The former professor finds he teaches almost as many classes in industry as he did on a university campus. He and his GE staff devote much of their time to conducting seminars on high efficiency to show how to reduce the two-thirds of total production time that is taken up by nonmachining operations such as setup and planning.

cost of making a product is in the manufacturing area, it is only sensible that more emphasis be placed upon applied engineering.

Q. Many people are concerned over how we can restore the craftsmanship that seems to be lacking in so many segments of U.S. production. Do you see this as a serious problem? If so, do you think the problem will resolve itself as we rely more and more on the "infallibility" of machines to turn out better and better products?

A. Lack of training in craftsmanship in U.S. production is a serious problem, and will become worse before it becomes better. The emphasis in the United States has been on high production at low cost, and craftsmanship with its high labor cost and low productivity is rapidly being replaced by superior designs of machine tools and better planning methods.

But it is still necessary to use the many craftsmanship techniques to get full utilization even from tape-controlled or in-line transfer machines. This craftsmanship must be recorded and used by the planner. Computerized subroutines may be used to store in memory some of these techniques, but in general the planner of tomorrow must be trained and upgraded to direct modern machine tools.

Q. Have schools provided the quality, if not the quantity, of engineering and technical graduates that modern industry demands?

A. A qualified no, in my opinion. When a dentist gets out of school, he knows how to build bridges and fill cavities, using the tools and techniques that are in current usage in his profession. He can hang out his shingle and go to work with passable proficiency. But the engineering graduate must start from scratch. Industry must train him all over again to suit its needs.

Perhaps our educational system should be reversed. Perhaps we should teach the student first to work, then to think. Perhaps first we should teach him the techniques of applying knowledge, then teach him the techniques of research.

U. S. engineers, you know, talk a good case. But when it comes to work they too often have clean hands. Maybe we should give our engineering students a job in a production shop first, so they could learn where to apply their knowledge and how to get things done. . . .

Despite the real advantages of a broad basic education, industry must somehow offset the general lack of know-how among graduates. Big industries, such as General Electric, are solving the problem with elaborate and effective training programs, but small industries are harder pressed.

Q. What, then, is the rest of the answer?

A. ASTME is a real part of it. Organizations such as ASTME not only can disseminate the latest and best knowledge of improved manufacturing processes, but can make a concerted effort to encourage universities and technical schools to place more emphasis on applicable manufacturing and engineering training. ASTME can sponsor adult training courses to upgrade personnel and train them in the use of new machines and methods. Just as important, the Society can spread the word that the U. S. economy is based upon economic production—some people seem to forget that fact, especially in election years—and that two-thirds of the cost of making a product is in the manufacturing area.

Q. How will automation and numerical control change machine tools themselves within the next decade?

A. The whole silhouette will change. No handles, no hands. Handwheels for controlling machine tool movements are already about as obsolete as a crank for a modern auto.

Q. Numerical control is the favorite shibboleth of those who worry about foreign competition, and it is your biggest crusade at GE right now. What is the NC outlook for small shops?

A. Numerical control devices are most useful in the small-lot production area, but may be used in the production of even a single part because they save the time required for multiple setups. Just recently a small shop in California announced its entry into job shop machining, using tape-

controlled machines for producing all of their components. This type of shop will take over the small-lot production and leave only the single piece parts to be produced on standard machine tools which do not have numerically programmed controls.

Q. What about the shape of things to come in the numerical controls systems themselves?

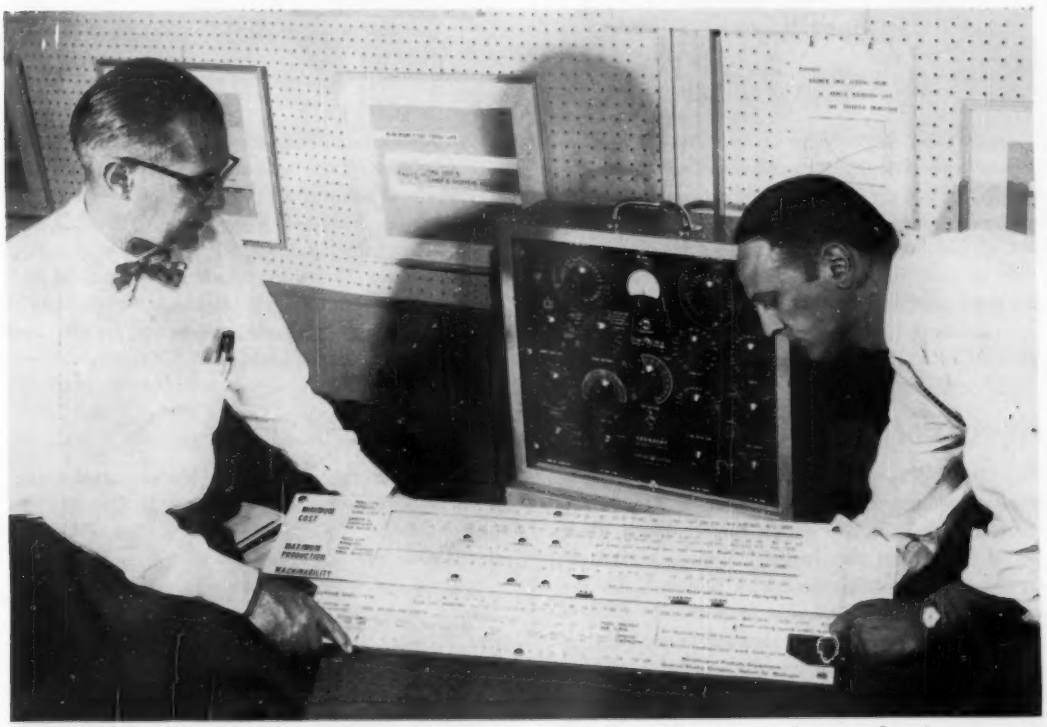
A. Numerical control units have been developed mainly in the past four years. New developments will rapidly obsolete the first models. Until designs become more stable, it should be expected that NC machine tools will be obsoleted more rapidly than the old standard machine tools.

Industry and engineers have just scratched the surface in computerized planning and machining. Programs such as APT developed by M.I.T., BACS developed by Boeing Aircraft Co., PRONTO by General Electric and similar programs developed by Cincinnati Milling, Giddings & Lewis, and others, allow the planner to use his time on the constructive selection of processes by using the computer to do all of the repetition and computation.

Eventually this will lead to the elimination of drawings, planning sheets, time study and operator instructions, substituting for these the punched or magnetic tape required for machine operation. This will be used to prepare the production planning and the wage rates for the machining area. . . .

Listed in Who's Who in Engineering and in American Men of Science, Dr. Gilbert has authored more than 65 articles and books on metalcutting. He belongs to four engineering societies and serves on a half-dozen committees. A former chairman of the Schenectady ASTME chapter, Gilbert has also served on the Society's metalcutting research committee and, when he left the University of Michigan, had been on the National Education Committee for several years. In 1953 he was specially designated by Society President Roger F. Waindle to explore student chapter activity, and as a result of his study submitted suggested bylaws which were adopted for the Society's student groups. Again, with fellow Prof. M. L. Begeman of the University of Texas, Gilbert prepared a special report of ASTME on-campus conferences.

Bill Gilbert, the family man, has a daughter in a Schenectady high school. A son recently finished his electrical engineering course at the University of Michigan and went to work for GE—as a stock chaser. "Good for him," says the father.



Consulting a yard-long version of the machinability sliderule that he designed is Dr. Gilbert and his right-hand man in GE's Machining Development Laboratory, Phil Visser. Against the wall is the Carboloy machinability computer, which the sliderule duplicates. The computer, one of 500 now in use throughout American industry, takes into account some 19 of the basic variables in the machining process. Both it and the sliderule were developed as part of a several-step program to apply scientific principles to metalcutting without the use of extensive mathematical formulas or standard sheets.

chapter news

USU Awards Scholarships In Tool Engineering

Frederick Preator (left), head of the Utah State University tool engineering department, presents checks for scholarships in tool engineering to Dr. Dean F. Peterson, USU dean of engineering.

LOGAN, Utah — Frederick Preator, head of the department of tool engineering at Utah State University, recently turned over to the college of engineering nearly $1000 in checks for scholarships in tool and manufacturing engineering.

In announcing the awards, Prof. Preator noted the great demand for tool and manufacturing engineers, both in that area and nationally. USU graduates of tool engineering have been able to choose from among many job offers, he said.

Recipients of the tool and manufacturing engineering scholarships are: Robert Goad, San Diego, Calif., $700 National Award of ASTME; David Parker, Logan, Utah, $150 Ray Hogan Award presented by McGee-Hogan Machine Co. in Salt Lake City; Dale Larsen, Rexburg, Idaho, $100 ASTME Student Chapter Award; and Robert Wright, St. Anthony, Idaho, $25 TME Award.

Newly Chartered Chapter Represents 50 Firms

DANBURY, Conn.—A recent addition to the Society, Danbury chapter is unusual in that its 90 members represent 50 firms. No doubt, this company diversity results from the industrial character of the city—once known as the world center of the hat industry, but now the home of a variety of companies making equipment ranging from bearings and paper products to transistors and electronic controls.

Continued growth of the Society in the New England area is tangible evidence of the resurgence of the nation's original states as thriving industrial centers, pointed out National President H. Dale Long when he officiated at the Danbury chartering on Oct. 26 in Bethel, Conn. The principal speaker of the evening was Dr. Harry B. Osborn, Jr., past national president; Philip R. Marsilius, national vice president, served as toastmaster. Also attending the ceremonies were Ray H. Morris, past national president, and W. J. Pender, Society director.

Danbury is the 5th chapter in Connecticut and the 168th in the Society. The following were installed as officers of the new chapter: Richard Van Harken, chairman; Pat Spafford, first vice chairman; Harold Jarvis, Jr., second vice chairman; George Tibbitts, third vice chairman; John Harrington, treasurer; and Edward Sharkany, secretary.

Chapter 16 Presents Engineering Scholarship

Congratulating Arthur Leeming, 1960 winner of Chapter 16's annual Tool Engineer Scholarship, is Edwin Smith, chapter first vice chairman. Onlookers are Sherman Hagberg, R.I.T. professor and chapter education committee chairman; and Fred Buehler, R.I.T. faculty adviser of Student Chapter 18.

ROCHESTER—Arthur Leeming, an engineering student at the Rochester Institute of Technology, is the 1960 winner of Chapter 16's annual Tool Engineer Scholarship. He is the 14th student to receive this honor in as many years. During the next three years Leeming will, by maintaining his present scholarship standing, receive $1500 from the chapter scholarship fund.

Rochester chapter's scholarship project was begun in 1946 when $100 was presented to a deserving student. This amount grew to $800 in '54, was increased to $1000 in '55, was later raised to $1200, and finally reached the present sum of $1500.

—O. E. Hosford

special events

ASTME Seminar "Metalcutting Today"	Dec. 7-8 1960	Dinkler Plaza Hotel Atlanta, Ga.
ASTME 29th Annual Meeting	May 20-26 1961	Statler Hilton Hotel New York City
ASTME 1961 Tool Show	May 22-26 1961	New York Coliseum New York City

Jack Delaney, Detroit, Dies

DETROIT—Funeral services were held here recently for John M. Delaney, member since 1935 of Detroit chapter, who died while visiting relatives in Miami, Fla. He was 63.

Delaney was widely known in the tool industry through his 25 years as manufacturers' representative with Goddard & Goddard Co. and through the last 15 years as owner of J & L Tool Sales, Detroit. He had held various committee positions in Detroit Chapter 1. Survivors include a daughter, three grandchildren and three sisters.

Reports in Brief . . .

Midwest

One hundred members of the MANSFIELD chapter, at their first technical meeting of the fall season, heard Dr. W. J. Kolff of the Cleveland Clinic speak on "Permanent Artificial Heart Inside the Chest." Colored movies added to the interest of the lecture, as he enlarged upon the subject of the manufacture of artificial valves and special surgical machinery built by tool engineers.

On a recent field trip, 110 members of LANSING Chapter 109 were welcomed by Universal Engineering Co., Frankenmuth, Mich. They were shown operations in the manufacture of drill bushings, component parts for milling and fixtures, and quick-change chucks.

Two films were shown at the recent meeting of SPRINGFIELD (Ohio) chapter. "One Hoe for Kalebo," sponsored by the National Machine Tool Builders Assn., compared modern methods of manufacturing with the outdated methods in some small countries who overlook the advantages of mass production. "Teamwork," sponsored by Bethlehem Steel Co., showed the manufacture and recommended uses for the various grades of tool steel.

North American Extrusions Corp. and Modu-Wall, Inc., were hosts to 90 members of KALAMAZOO chapter for a plant tour. In the extrusion areas of the plant, aluminum is extruded by means of a 1250-ton Loewy hardpress into a variety of shapes, mainly for architectural application of building products. In the fabrication area, extruded bars are machined and assembled into units of the curtain-wall system. Completed exterior walls using this system may be seen in a number of buildings in Kalamazoo.

South

"The Science of Metrology" was the subject of a talk given by Lednard Whitten, supervisor of the Gage Div. of the Union Carbide Nuclear Co., Oak Ridge, Tenn., to 55 members of CHATTANOOGA chapter at its regular monthly meeting.

Australia

At the Aug. 10 meeting of SYDNEY Chapter 144, R. J. Wright, chief engineer of Polson Div., Automotive Components, Ltd., Footscray, Victoria, spoke on "Piston Manufacture and Tooling." A question and answer period followed the lecture, which was illustrated by slides.

Northeast

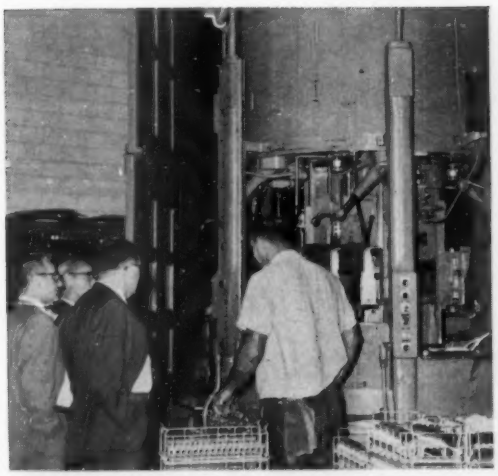
William S. Mazar, BINGHAMTON member, who recently won honorable mention in the Gadgets contest sponsored by THE TOOL AND MANUFACTURING ENGINEER, has been honored again in winning the second prize in a similar contest by *American Machinist*. The title of his contribution was "A Plan for Improving the Efficiency of the Model Tool Shop Through the Layout."

At a recent technical session of GREATER NEW YORK chapter, Harry Conn of Scully-Jones & Co. spoke to 100 members and guests. In discussing the economics of tooling, he emphasized the importance of proper coordination of sales engineering and production in order to effect efficient operation.

A plastic tooling engineer for Westinghouse, Air Arm Div., Charles Larson, B.S.M.E., told 125 members of BALTIMORE chapter about the advantages of plastic tooling from an economy standpoint. He emphasized the flexibility and short lead time and also the minimum tool design needed for such tooling, and described the manufacture of tools such as form dies, milling and checking fixtures, and molds for plastic parts made from the piece part itself. A movie produced by the U.S. Gypsum Co., showing the manufacture of plastic tools from their tooling resins, followed the lecture.

The derivation and history of magnesium and its use for lightweight tooling was the topic at a recent meeting of ITHACA chapter. Larry Zerome, chief engineer, Dow Chemical Co., and Herb Buzzard, tool engineer at A. R. Purdy Co., Inc., stressed a number of points showing the stability of magnesium in the presence of various acids, alkalis and many organic chemicals. They brought out the fact that the ability of magnesium to absorb shock loads, coupled with good strength and rigidity, reduces the chances of permanent damage, such as dents, bends and twists in the magnesium assembly. Dow Chemical Co. has developed a series of cans and wrought magnesium alloys to be used at temperatures in excess of 700 F, to meet the demand placed upon the light-metals field by airframe design requirements.

Plant Tour Camera



FRAMINGHAM, Mass.—One of the first steps in the production of an industrial process control instrument, this precision machining operation is performed at the Foxboro Co.'s plant in Foxboro, Mass. While touring the plant's machine shop, finishing department, subassembly department and final assembly department, Framingham chapter members observed all the various production stages of pneumatic and electronic instruments. *—Richard T. Benger*

MADISON—Assembling six-piece caps for ball-point pens at a rate of 2880 per hour, this 16-station assembly machine replaces 17 workers on a one-shift basis, saves 600 sq ft of floor space and provides for automatic inspection as assembly of a product progresses. The cam-actuated machine, demonstrated by the Parker Pen Co. during a Madison chapter plant tour, can be used to assemble anything from delicate electronic assembly to an automobile part.

"The Human Brain has No Sex . . .

. . . You became a draftswoman because of your ability—don't ever be apologetic because you're a woman." During 15 years of making her way in a man's world, Suzan Parnakyan has remembered—and remembered to live—these words of wisdom from an M.I.T. graduate who was her supervisor. Perhaps that is why she pioneered as the first woman ASTME member in New England. Active in the Hartford chapter, Suzan is now cochairman of their public relations committee. Since coming to this country from her native Istanbul, Turkey, she has racked up experience in tool designing, technical illustrating, time study, drafting and other areas of engineering. She is presently employed at the Gerber Scientific Instrument Co. A gal who builds Hi-Fi sets and FM tuners, Suzan can be called almost anything but ordinary.

An Informed Society . . .

LONG ISLAND—Telling the story of Project Mercury at a Long Island chapter meeting, Albert R. Mead gives some interesting facts on the how and when of putting a man into space. Metallurgist at Grumann Aircraft and Engineering Corp. and vice chairman of their aerospace research and testing committee, Mead discussed recovery of an astronaut, as well as the heat, shape, vibration and livability of the capsule that will ride man into space. With the launch date less than a year away, said Mead, seven astronauts are being rigidly trained for an orbital flight; however, none of the seven will know who is the "lucky" one until a few hours before blast-off.
—Harry MacDonald

MONTREAL—Standing beside the PT-6, a turboprop engine, Montreal Chapter Chairman F. Winkworth (right) gives an enthusiastic handshake to the man who was responsible for the design and development of this engine, J. P. Beauregard. At a joint meeting of the Engineering Institute of Canada and ASTME Chapter 50, Beauregard, a project engineer at Canadian Pratt & Whitney Aircraft Co., Ltd., explained the technical problems that were met in the development of the PT-6. *—Louis Balint*

SOUTH BEND—Chapter 30 members are well briefed on tapping since hearing the above pictured panel discuss the subject at their monthly technical meeting. Left to right are Willis Watson, Besly-Welles Corp.; Walter Marek, Threadwell Tap & Die; panel moderator George Frepan, Bendix; Wayne C. Hitchcock, Butterfield Div., Union Twist Drill; and Bob Ferguson, Greenfield Tap & Die. *—Bert E. Bennett*

. . . is a Good Society

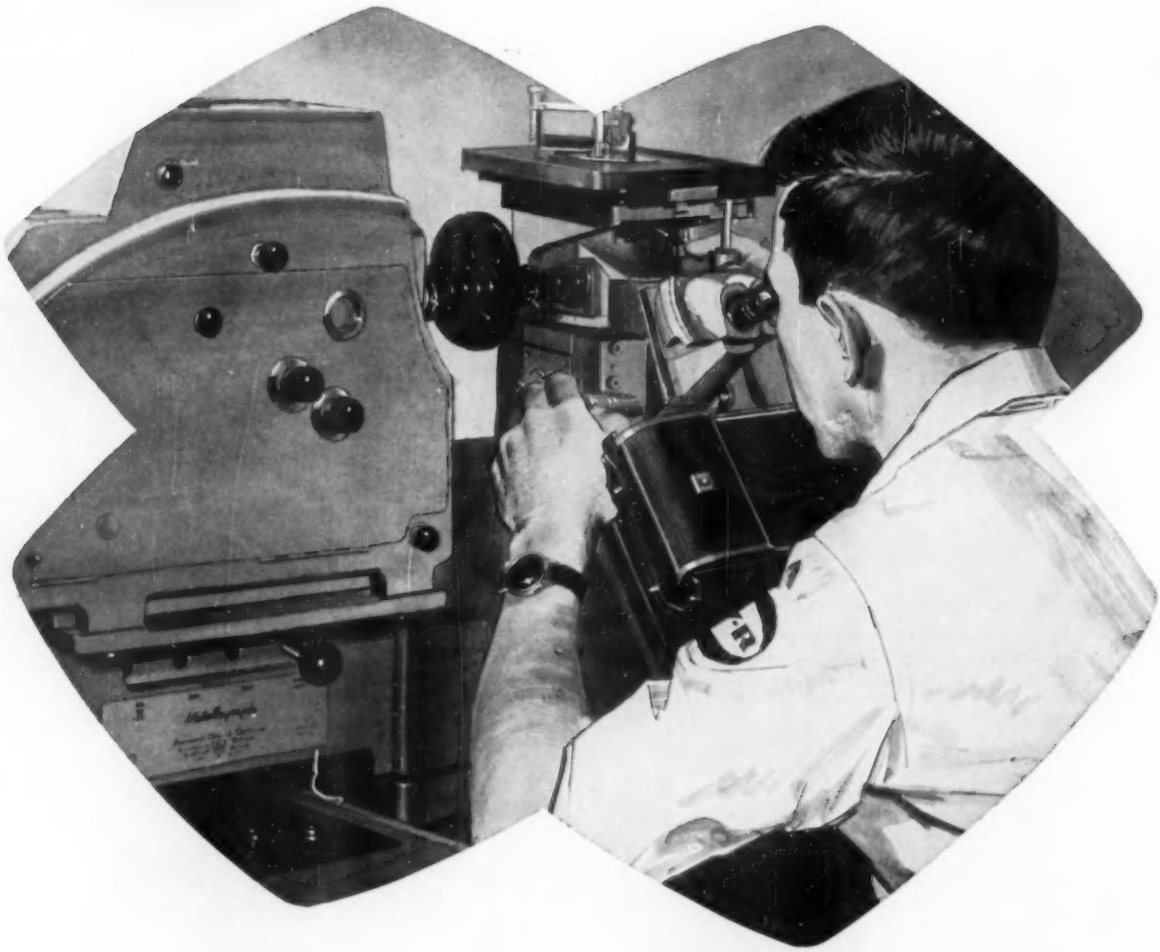
OAKLAND—Discussing Golden Gate chapter's bulletin are Chairman John E. Wilson (right) and John Denny, sales manager of Die-Draulic Grip, Inc. Denny spoke on die design at a recent chapter technical session. *—Art Pederson*

PEORIA—Harry De Leon (left) and Les Reddard (right) spoke before more than 90 members and guests of Peoria chapter. In a talk on "High-Speed Forming," Reddard explained the Convair Dynapak machine. De Leon spoke on fishing. Also shown are Program Chairman Wesley Leveck (center left) and Robert Kolb, technical chairman. *—Robert K. Hohulin*

SANTA MONICA—Posing with Chairman Harold Hanmer (center left) are three speakers who recently informed members of Santa Monica Bay Area chapter on the history and industrial applications of "Man-Made Diamonds." Representing The Carborundum Co. were: John W. Ripple (left), who for the last 18 years has specialized in the field of diamond wheels, particularly in the grinding of tungsten carbide; and John A. Mueller (center right), who has directed laboratory application evaluation of such new products as man-made diamond wheels, dense-structure snagging wheels, granular rubber wheels and open-structure toolroom wheels. From General Electric Co. came Norman L. Leventhal, a diamond application engineer who has worked in diamond process development. *—Charles V. Livezey*

V-R

CREATING THE METALS THAT SHAPE THE FUTURE



Constant Checking Assures Carbide Consistency

It's no wonder that V-R carbides give consistent performance under any circumstance. Carbide consistency is largely due to the varied and frequent quality checks at every step in production processing. Here, we see a metallograph being used to check grain structure and absence of porosity against rigid standards. Similar checks are made constantly to assure proper hardness, density, and transverse rupture strength. Each and every piece of any V-R grade always will perform the same. Yes, quality control here at V-R is important to you.

V-R VASCOLOY-RAMET

826 MARKET STREET • WAUKEGAN, ILLINOIS

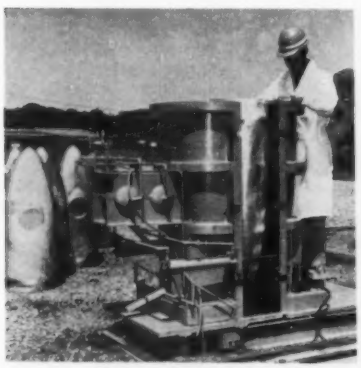
C-801

Use Reader Service Card, CIRCLE 37

Progress in Production

SHAPING COMMON METALS —A NEW HORIZON IN EXPLOSIVE FORMING

Production parts of common metals are being explosively formed in high quantities by Rocketdyne, a division of North American Aviation, Inc., for Atlas and Saturn rocket engines and for Hound Dog air-to-ground missiles.



Facility is used in explosive forming of aluminum pylons that attach missiles to wings of B-52 bombers.

Formerly, the process of explosive forming was directed toward difficult, high-strength materials.

"We have demonstrated conclusively that the repetitive forming of common metals can be achieved at competitive costs," stated Dr. L. C. Stuckenbruck, supervisor of the division's explosive forming activities. "Our thrust chamber tubes, for example, are made from nickel and 20CB steel. We have used explosive forming to square the ends of more than 2000 tubes to close tolerances with negligible rejections—and at a savings of about $10,000 over other processes."

Other parts formed explosively include a quantity of small, stainless-steel thrust chambers for a drone rocket engine and 6061 aluminum pylons to attach Hound Dog missiles to the wings of B-52 bombers.

"In many instances, explosive forming is the only method by which newer, more difficult parts can be formed," Stuckenbruck said. "One example of this is the turbine manifold shroud that we are forming out of René 41 for the F-1 engine, which develops 1.5 million pounds of thrust."

Explosive forming makes possible substantial savings in the cost of dies. When stiffeners for a large bulkhead for the B-70 airplane were formed explosively with a single female die, the tooling cost was nearly $500,000 less than that required to form the parts by drop hammer, using male and female dies.

"Speed is another important factor in considering explosive forming," noted Stuckenbruck. "For example, we were able to form a small thrust chamber for a rocket engine only 36 hours after it was decided to begin fabrication of a die."

Geyser of water rises from forming pit after charge is set off.

Rocketdyne began work in the explosive forming field more than five years ago. The company has successfully formed parts ranging in size from ¼-inch-diam tube ends to parts more than 5 ft in diameter, and have conducted experiments in explosively flattening metal sheets that have warped during welding or heat treat processes.

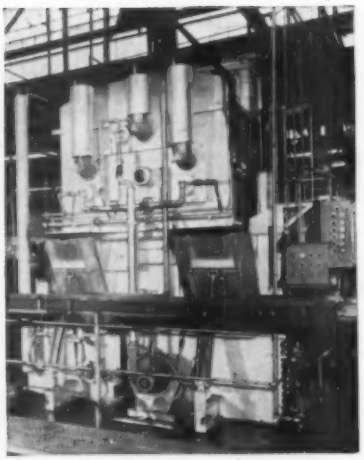
The division has announced that its technical staff and explosive forming facilities—located at the Propulsion Field Laboratory in the Santa Susana mountains of California—will be offered to other industries for the investigation of metalworking problems.

NEW MACHINE REDUCES TIME AND COST OF MATERIALS TEST PROGRAM

Testing 15 specimens simultaneously in an identical temperature environment, a flexural creep test machine shaved five years and five months—plus five-sixths of the cost—off a materials test program at Boeing Airplane Co. The program involved testing more than 100 specimens of epoxy resin laminate tooling materials at constant stresses from 3 to 50 percent of breaking load and for periods of 500 hours at room temperature and at 120 F.

Designed by manufacturing development engineer Vincent Yuhas, the testing device consists of a 6-ft rectangular metal case that forms an enclosed tem-

Dial indicator shows deflection measurements as it is moved along top of loading rods on testing machine.



HOLCROFT

Production Heat Treating Equipment

For any of these processes:

- ✓ ANNEALING
- ✓ BRAZING
- ✓ CARBURIZING
- ✓ CARBO-NITRIDING
- ✓ CARBON-RESTORATION
- ✓ FORGING
- ✓ HARDENING
- ✓ SINTERING
- ✓ NORMALLIZING
- ✓ TEMPERING

HOLCROFT & COMPANY

6545 Epworth Blvd., Detroit 10, Mich.
Phone TY 4-5700

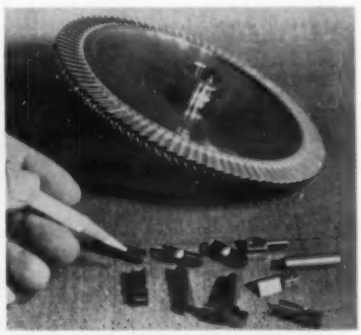
44 YEARS OF ENGINEERING LEADERSHIP
Use Reader Service Card, CIRCLE 38

Progress in Production

perature-controlled test chamber and houses 15 loading rods. Weights of 1 and 5 lb are placed on the rods to apply desired percentages of breaking loads to test specimens beneath the rods. Temperature environments are regulated to 200 F by heating the sealed, water-filled base of the device. A dial indicator shows deflection measurements and a humidity gage records relative humidity.

SHEET METAL BUCKETS LIGHTEN TURBINE WHEEL

Sheet metal buckets eliminated more than 50 percent of the weight and cost of a turbine wheel designed by General Electric Co. Lighter than conventional cast-and-machined buckets, the new high-temperature, nickel-base-alloy buckets lessen the weight of both the



Sheet metal buckets and blanks are used to make turbine wheel.

wheel itself and the containment shroud. In turn, low inertia of the lightweight rotor can simplify control mechanization.

The turbine wheel was designed for a fuel pump used in the comany's J93-3 jet engine, powerplant for the North American B-70 Mach 2 bomber. This is the first practical application of sheet metal buckets to turbine wheels, according to G. E. engineers.

GLOVEBOX MILL PROCESSES NUCLEAR AGE MATERIALS

Completely enclosed in a controlled atmosphere glovebox, a new combination rolling mill at the Argonne National Laboratory, Argonne, Ill., is currently processing alpha-active pyrophoric Nuclear Age materials such as plutonium.

Remote control operation with the glovebox enclosure is facilitated by the mill's mechanized roll changing device. The device includes a roll storage car,

AN ADDED SERVICE TO ASTME MEMBERS

$5.00 worth of coupons for $3.00

Good for any Single Technical Paper of any year

Each of the attached coupons can be redeemed for one (1) ASTME technical paper
Total cost of Set of 10 Tickets, $3.00—Value $5.00

ASTME MEMBERS ONLY

SAMPLE

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

This coupon is good for ONE (1) TECHNICAL PAPER
EXPIRES DECEMBER 29, 1961

SAMPLE

Clip, Fill-out and MAIL TODAY

To: PUBLICATION SALES DEPARTMENT
American Society of Tool and Manufacturing Engineers
10700 Puritan Avenue, Detroit 38, Michigan

Enclosed please find $..... for .... sets Technical Paper Coupons.

Name

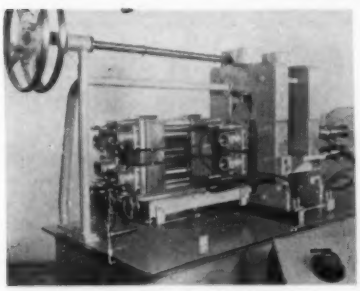
Chapter No.

Address

City Zone State

three slideways to carry three roll assemblies, quick-disconnect screwdowns and universal spindle supports. Complete roll changes can be performed in a matter of minutes.

Designed and built by Loma Machine Mfg. Co., Inc., the mill is operated in either a 6 x 8-inch two-high setup or in a 1½-inch and 6 x 8-inch four-high



Combination rolling mill has handwheel for moving roll assemblies.

setup. The two-high arrangement is used for either hot or cold breakdown rolling of plate and sheet; also available are grooved rolls for processing rounds from 1 to ¼ inch in diameter. In the four-high setup, strip is cold finish rolled to gages as thin as 0.002 inch.

The forged alloy steel rolls are heat-treated to 100 Shore Scleroscope hardness and contain special cartridge heating elements to prevent undue chilling of materials being hot worked. Current for the heating elements is fed through slip rings and brushes mounted at the outboard side of the mill. The roll necks are mounted in needle roller bearings having a total separating force capacity of 175,000 lb.

SPECIAL TOOLING UPS WHEEL PRODUCTION

Two special machines with slug and throwaway insert carbide tooling are reducing machining costs in the production of railroad car wheels in the cast steel wheel plant of American Brake Shoe Co., Calera, Ala. Production per machine has increased from 3 wheels per hour turned aud bored, to 25 wheels per hour bored and 9 wheels per hour turned.

Boring head with inserts performs three-step rough boring in one pass.

A special boring head that accommodates six square inserts, permits three-step rough boring in one pass. Life per cutting edge of the inserts averages 50 wheels of 255 Brinell hardness. Boring is done at 90 rpm and 0.083-inch feed per revolution, removing 10 lb of steel.

The turning mill runs at 30 rpm with 0.041 to 0.062-inch feed and removes 50 lb of steel per 33-inch-diam wheel. Insert life averages two to five wheels per indexable cutting edge. The special tooling includes: a face hub that roughs with a 1-inch square by ¼-inch insert and finishes with a 1¼-inch-diam by ¼-inch insert; a face rim that roughs with a 1¼-inch-diam by ¼-inch insert and finishes with a 1-inch square by ¼-inch insert; a profile flange with two 1¼-inch-diam by 2¼-inch-long slugs; a turn tread with one 1¼-in-diam by 2¼-inch-long slug; and a special brazed-tip tool called a rim radius. Kennametal, Inc. furnished the boring head and six square inserts.

From More Than 1200 ® Catalog Items...

Carbide Tipped Saws

402-9

CIRCLE R carbide tipped saws — perfected by unique heat treating — increase production, *retain their tips.* Shown here is only one of many carbide tipped and solid tungsten types from our catalog of 1200-plus items. We also design special orders.

Consult a CIRCLE R *Specialist in . . .*

BURBANK, CHICAGO, CLEVELAND, DAYTON, DETROIT, HACKENSACK, INDIANAPOLIS, MEMPHIS, MILWAUKEE, MONTREAL, NEW HYDE PARK, NEW YORK CITY, PHILADELPHIA, PHOENIX, PITTSBURGH, PROVIDENCE, ROCHESTER

CIRCULAR TOOL CO., INC.

PROVIDENCE 5, RHODE ISLAND

Specialists in Circular Cutting Tools Since 1923

METAL SLITTING SAWS • COPPER SLITTING SAWS • SCREW SLOTTING SAWS • COMMUTATOR SLOTTING SAWS • JEWELERS' SLOTTING SAWS • CUT OFF SAWS • CIRCULAR KNIVES & ROTARY SHEAR BLADES • CIRCOLOY STEEL SAWS • SOLID & TIPPED TUNGSTEN CARBIDE SAWS • COMBINED DRILLS & COUNTERSINKS • CENTER REAMERS

Use Reader Service Card, CIRCLE 40

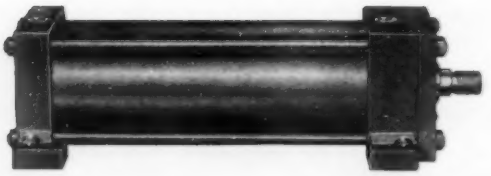
SAVE TIME, AIR, MONEY

with PARKER-HANNIFIN One Source Engineering

Your pneumatic system shapes up faster at the design stage when one man can discuss with you every component you'll need. But have you realized how much your Parker-Hannifin man can save you in money and air?

Just for instance . . . your valves don't have to be ¾" just because the cylinder size you select comes with ¾" ports. Your Parker-Hannifin man chooses valve types and sizes to suit the air flow you'll need. He'll show you too, how pressure control saves money and air, how a smaller lubricator is often a more efficient lubricator, and other money saving ideas. Then he'll show you ways to "tube up" and "hose up" a leakproof pneumatic system quicker, neater and at lower cost.

Call your nearest Parker-Hannifin sales office, or write direct for complete information.



Low friction, long packing life are money-saving features of the Hannifin Series "A" pneumatic cylinder, available in a full range of mounting styles and from 1½" to 14" bore, strokes to 20 feet. Hannifin cylinder application data and charts make selecting the right Series "A" cylinder easy. Get yours from your Parker-Hannifin man.

DUAL SOLENOID, 4-WAY

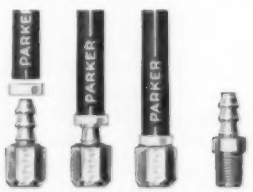
PRESSURE, 3-WAY

HAND, 4-WAY

CAM, 3-WAY

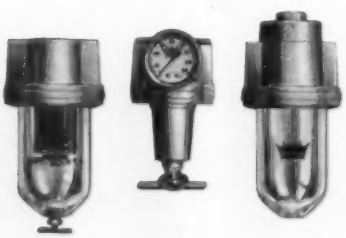
Use flow factors as money-savers—your Parker-Hannifin man can show you how. They help you to avoid "oversizing" your valves. Hannifin's new Valve Finder gives "C_V" ratings for every valve in the line, makes it possible for you to take full advantage of the extra air-flow capacity in Hannifin air valves. Get your copy today.

Pneumatic systems tube up fast with Parker "Intru-lok" tube fittings. Use them with copper, nylon or "Parker-POL" polyethylene tubing. Just insert the tube and tighten the nut for a leakproof "bite-type" joint.



Another time-saver is "Push-lok", the Parker hose-and-hose-fittings combination for pressures to 250 psi. No tools needed. Just push this hose on these hose fittings. They won't blow off, ever, not at twice 250 psi.

One air line connection installs the Hannifin Air Motor . . . an integral solenoid valve controlling a fast, rugged double-acting air cylinder. Built-in speed controls adjust piston speed in either or both directions.



You will save both air and money with Hannifin "Crown" air line filters, pressure regulators and lubricators. Let your Parker-Hannifin man show you how they pay for themselves by making it possible to get all the air flow you need at the exact pressure that will best do the job. "Crown" filters and lubricators will bring further savings through reduced equipment maintenance.

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
HANNIFIN COMPANY
A DIVISION
519 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

2180-PH-a

TOOLS of today

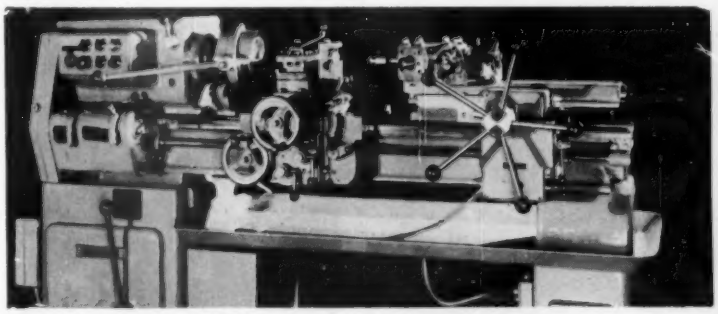
Hydraulic Cylinder Cushion

Designed for hydraulic cylinders having bores from 1½ to 14 inches, this self-regulating cushion makes faster cycling possible. In high-speed cycling, the floating cushion plunger acts as a check valve that allows comparatively large volumes of fluid to enter the cylinder around the piston rod. The ball check assembly customarily used is replaced with a second adjusting screw which, together with the regular cushion adjusting screw, permits easy access for cushion adjustment with either of the two screws. For slow-speed cycling, the sleeve automatically readjusts to full diameter to keep clearances to an absolute minimum.

Miller Fluid Power Div., 7N015 York Rd., Bensenville, Ill. **Circle 401**

Ram Type Turret Lathe

Model 3R universal ram type turret lathe can be used as a chucking machine, for bar and collect work and for straight turning and facing operations. Bar capacity of the machine is 1½ inches, the swing over the bedways is 15 inches and the swing over the crossslide is 8 inches. The lathe has six working stations and is equipped with a power feed box, a universal carriage



which provides both power longitudinal and power crossfeeds through apron clutches, a 60 pitch gear box, a precision leadscrew, a thread-chasing dial, front and rear tool blocks for the crossslide, coolant pump and piping, oil pan and splash guard.

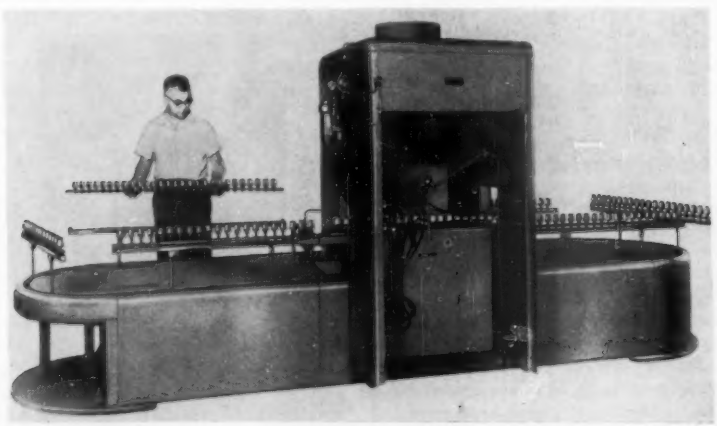
Sheldon Machine Co., Inc., 4258 N. Knox Ave., Chicago 41, Ill. **Circle 402**

Multiple Coat Painting Machine

Designed for prime and finish coating, baking, and metallizing, the machine illustrated can be used in multiple coat painting operations or as a conventional chain on an edge painting machine. Each part to be coated is loaded to a workholder on a spindle. The spindle, instead of being attached to a moving chain, are on carrier rods independent of the chain. When a carrier rod is placed on the machine, 20 to 30 parts are loaded at once.

The machine can be used either with rotating or nonrotating workholders. For long runs the parts can be loaded on the carrier rods automatically and coated at speeds up to 30,000 per hour. Machine speeds range from 200 to 600 carrier rods per hour. Speed of part rotating is also adjustable.

Finish Engineering Co., 921 Greengarden Rd., Erie, Pa. **Circle 403**



Magnet-Operated Limit Switch

Designed for operation without physical contact of levers, rods or shafts, the magnet-operated limit switch is well-suited for applications of a highly repetitive nature where long life and high reliability are important. The controlling is done by passing a permanent magnet near the face of the switch.

The switch can be applied to detect moving objects and to functionally replace vane-operated limit switches where there is no opportunity to pass a vane through a slot. Permanent magnets can be installed on any part of the equipment—movable or stationary—to be controlled and both magnet and switch can be fixed and the switch operated by passing a vane of magnetic material

IT'S A FACT
YOU CAN DO BETTER WITH
DE-STA-CO
CLAMP-ABILITY

No matter what the size or shape, when you need constant, accurate holding power, the sturdy "clamp-ability" of De-Sta-Co Toggle Clamps is the answer.

More than 25 years of manufacturing experience is reflected in each of over 140 models—from the 1-oz. Tiny Toggle with 50 lbs. holding pressure to the giant 5-lb. model with 2-tons of clamping force.

And for the unusual application, our engineers will show you how easily one may be adapted. Inform yourself about De-Sta-Co "CLAMP-ABILITY"...

FOR MORE FACTS
REQUEST
INFORMATIVE CATALOG
YOU CAN
DEPEND ON DE-STA-CO

DETROIT STAMPING COMPANY
150 MIDLAND AVENUE
DETROIT 3 MICHIGAN
DE-STA-CO

Use Reader Service Card, CIRCLE 42

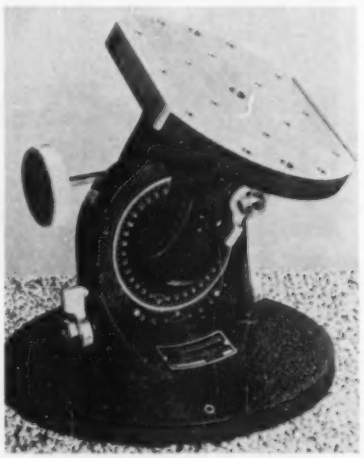
between the two.

The magnets are available with 5/8-inch diam and 2½-inch length and 1⅛-inch diam and 7-inch length. The switch has a contact rating of 0.75 amp make, 0.2 amp carry and break at 115 volts a-c. Response time is 0.001 sec.

General Electric Co., Schenectady 5, N. Y. **Circle 404**

Compound Angle Setup Device

Consisting of two 360-deg protractors set at 90 deg to each other, a mounting plate and a base, the Derry Triangulator is used for compound angle setup problems. Any compound angle on a spherical arc can be set, adjusted and locked to within one minute of arc. The device, incorporating common axis

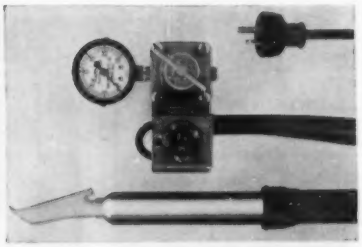


center-of-gravity rotation to prevent sag by reducing load leverage to a minimum, is available in two sizes with load capacities to 300 lb. It is applicable for inspection, layout work, grinding and drilling.

Scientific Engineering Co., 11126 Weddington St., North Hollywood, Calif. **Circle 405**

Thermoplastic Welder

All operations from tack welding to high-speed welding can be performed with Kalmar Model 12-AW welder. Designed for thermoplastics such as polyethelene, polyporpylene, PVC and plasticized tank lining, this unit can be used for both shop and field work with a production rate of 60 ipm. Supplied with a tacker tip and one round tip, it has a three-heat metal heat element



with an output to 8000 watts. A metal-cased rotary switch, a pressure gage, an air-flow regulator and a 16-ft neoprene air hose are furnished. The unit can be plugged into any 115 volt a-c outlet.

Kamlar Products Co., 932R Washington St., Norwood, Mass. **Circle 406**

Hacksawing Machine

Built for continuous duty, the Velox 6-inch high-speed hacksawing machine has a round and square capacity of six inches and weighs 475 lb. The model has a hydraulically controlled feed with automatic lift and automatic cut-out on completion of the cutting cycle. The feed is controlled to give adjustable, full or immediate elevation, or normal relief cutting. The vise can be set for right-angle cutting and angular cutting up to 45 deg.

Elliott Machine Tools, Port Hope, Ont., Can. **Circle 407**

A-2 Tool Steel

Mineor FM is a deep-hardening, non-deforming tool steel (AISI-SAE A-2) with free-machining properties. The addition of alloy sulfides imparts improved machinability and a self-lubricating action for die parts. It resists deformation in heat-treatment, works well in blanking and shearing of dies for heavy materials and has greater toughness than most tool steels. In

hollow-bar form, it is suited for hollow punches on heavy metal, blanking dies, toolholders, and wear-resistant machine and die parts. It can be cut to short lengths for sleeves, bushings and guides.

The steel hardens between 170 and 1775 F to give 63 to 65 R_C and the Izod impact strength at R_C 62.5 is 104 ft-lb. Sizes are from 2¼ to 16¼ inches OD and from ¾ to 9¾ inches ID with wall thicknesses from ¾ to 4½ inches.

Darwin & Milner, Inc., 2222 Lakeside Ave., Cleveland 14, Ohio. **Circle 408**

Angle Plates

Granite six-face Universal right-angle plates are available in two sizes—6 x 6 x 6 inches and 6 x 9 x 6 inches. Both sizes are made to two accuracies

—laboratory grade (0.000025 inch) and inspection grade (0.000050 inch). The face and base of the plate are each 1⅞ inches thick.

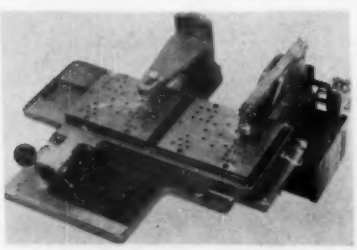
Rahn Granite Surface Plate Co., Dayton 7, Ohio. **Circle 409**

Positioning Table

The need for jigs and fixtures for drilling, reaming, tapping, etc. operations is eliminated with this positioning table. It has a table working area of

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

4 x 5 inches and positioning accuracy of ±0.0005 inch. At the release of a thumb button on the table positioning handle, an air-operated shot pin drops into a hole in the master template, locking the table in position. This template has the diameter hole pattern of the part to be produced in single diameter and, when mounted, is in exact register with the workholding subplate



and locating template. The workholding subplate provides tool clearance for drilled through holes; the locating template is mounted under the handle pointer and shows the relative position of the table. Where the degree of accuracy is such that bushings are required, an outboard support bracket with its own bushing liner can be used.

Burgmaster Corp., 15001 S. Figueroa St., Gardena, Calif. **Circle 410**

Plasma Gun

Intended for spraying molten refractory oxides and ceramics onto other materials, the Plasma Gun—a small plasma generator—operates at 2500 to 12,000 F. It is powered by a standard welding generator. The unit consists basically of a water-cooled tungsten cathode and a copper anode. In spraying, the material to be applied is fed as

a powder into the plasma arc, becomes liquid and is thrown in fine drops against the surface to be coated. The unit can be fired into a vacuum or pressure chamber without major change.

Avco Research and Advanced Development, 201 Lowell St., Wilmington, Mass. **Circle 411**

Epoxy Adhesive

Maraset resin 533A—a two component, contact pressure, room-temperature curing adhesive—is a solvent-free, nonvolatile, medium-thick paste with a 2-hr pot life. It can be used to join aluminum, steel, brass, copper, magnesium and combinations of these metals. It can also bond wood, glass, rubber and plastics. Properties include low shrinkage; good resistance to mechanical and thermal shock; high creep resistance under constant stress; low moisture absorption; good resistance to

IT'S A FACT

YOU CAN DO BETTER WITH

DE-STA-CO

AIR-OPERATED TOGGLE CLAMPS

600-4000 lbs. holding pressure

300 to 900 lbs. clamping pressure

De-Sta-Co air-operated clamps are built to give long, trouble-free service . . . hardened bushings and pivot rods are standard of the many quality features.

Clamping and unclamping are both actuated by normal air line pressure of 90 lbs.

Whatever the use: Series, sequentially, simultaneously . . . or individually, De-Sta-Co air-operated Toggle Clamps hold securely—speed production!

FOR MORE FACTS
WRITE FOR TEMPLATE SET AND CLAMP CATALOG

YOU CAN DEPEND ON DE-STA-CO

DETROIT STAMPING COMPANY
350 MIDLAND AVENUE
DETROIT 3, MICHIGAN
DE-STA-CO

Use Reader Service Card, CIRCLE 43

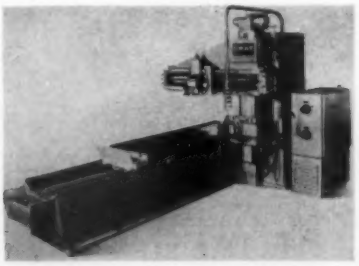
water, chemicals, oils, solvents and aromatic fuels; and high shear strength, tensile strength and hardness.

Marblette, Inc., 37-31 Thirtieth St., Long Island City 1, N. Y. **Circle 412**

Universal Planer

Ways of the Flying Scot planer are made with laminated plastic plates, providing higher load carrying capacities than possible with cast-iron ways, reducing the generation of heat at the bearing surfaces of the vees and eliminating cutting and scoring of the bed.

The planer, for carbide planing, is available with single or double cutting heads. It has square locked components throughout to resist torsional deflection and vibration produced in double cutting and a pendant station for control of table movement. It is powered by a 60/75 hp variable voltage drive. The motor is adjusted, in the cut and return direction, from 180 to 1800 rpm. The standard planer ratio is 6:1, which provides table speeds of 30 to 300 fpm.

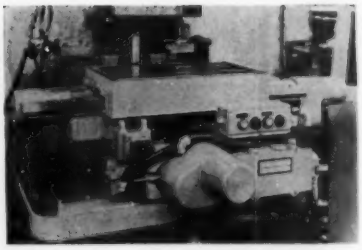


Nine combinations of table widths and heights are available. Basic sizes are 30, 36 and 42 inches.

G. A. Gray Co., Cincinnati 7, Ohio. **Circle 413**

Positioning System

The MPI 801 numerically controlled point-to-point positioning system is accurate to 0.0001 inch. The system includes a control console and a MPI 850 positioning table. The console is completely transistorized. With this system, actual movements of 0.0001 inch can be realized without oscillation. It utilizes punched paper tape. Among the features of the system are modular plug-in construction, infinitely floating zero references and extremely rapid positioning from either direction up to 200 ipm. It has self-indicating checks and direct visual display of actual positions. It is



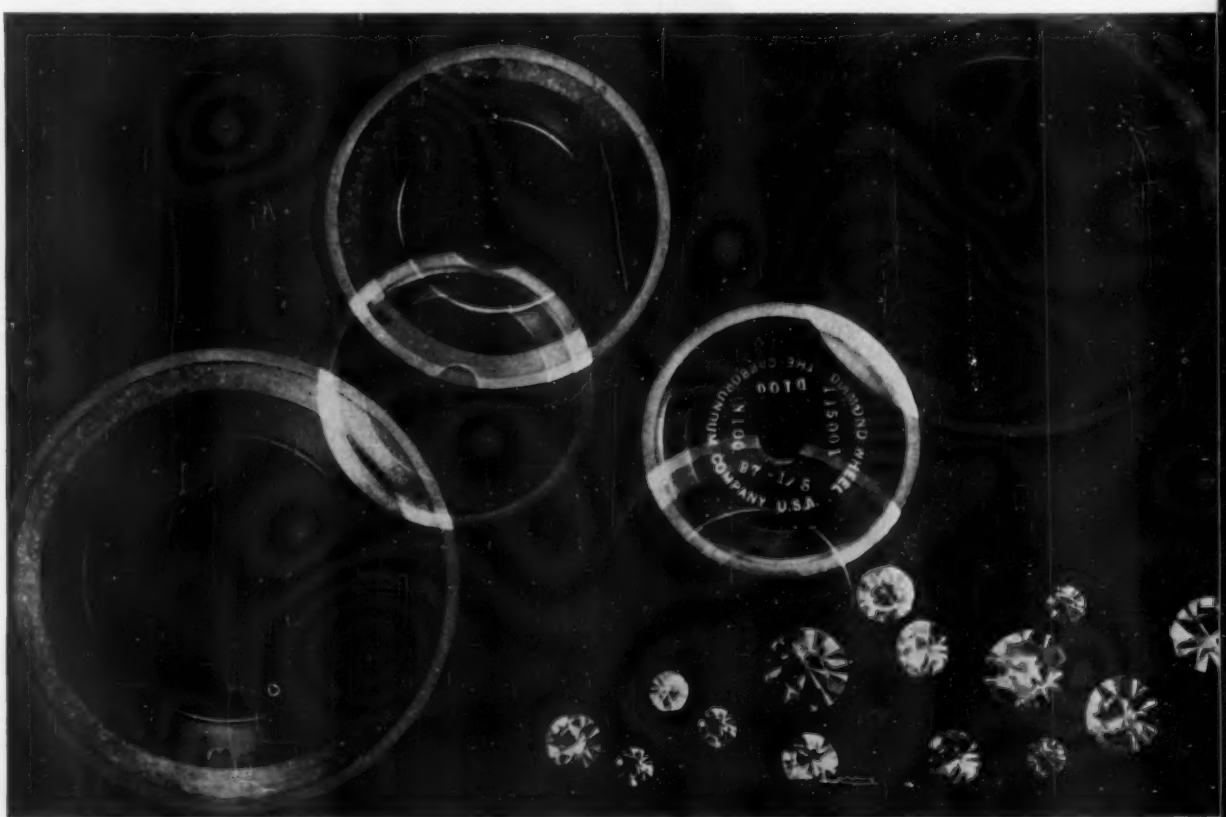
expandable into a complete contouring system with the addition of an interpolator and is usable for any positioning application. As many axes as required can be provided.

Micro-Path, Inc., 10321 Anza Ave., Los Angeles 45, Calif. **Circle 414**

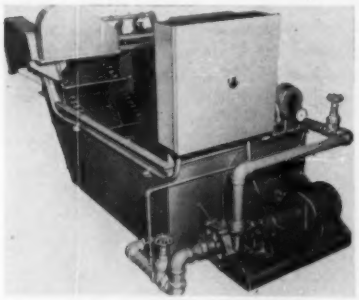
Automatic Coolant Filter

Paper and other replaceable filtering media are eliminated with this self-cleaning automatic suction filter. Swarf, metal particles, dirt, etc. collect on the top of the screen, forming a filter mat which filters progressively to low-micron particle size as the dirty coolant or

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION



waste material is pumped through a screen. As the filter mat becomes deep enough to decrease the flow of filtered coolant, a switch is activated, starting the conveyor. This moves the mat,



clearing a portion of the screen and restoring the flow of filtered coolant to normal rate. The filter is available in capacities from 25 to 2500 gpm.

Henry Mfg. Co., 530 E. Reed St., Bowling Green, Ohio. **Circle 415**

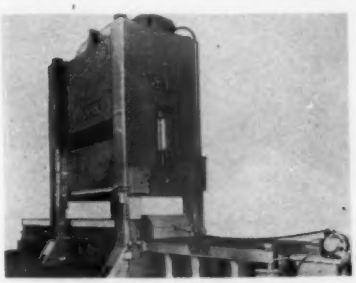
Adjustable Center

Aligning work from the grinder tailstock or headstock on cylindrical grinders, cutter grinders, gear shavers, lathes and tracer attachments is accurately performed with the Micro-set adjustable center. The unit consists of an eccentrically ground sleeve and arbor. Each calibration moves the tip 0.0005 or 0.001 inch on diam, the total tip movement in either direction being 0.006 inch. It is available in Nos. 2, 3 and 4 Morse taper, Nos. 6 to 11 Brown & Sharpe taper, Nos. 6 to 12 Jarno taper and ¾ to 1½ inch straight shank.

Enco Mfg. Co., 4520 W. Fullerton Ave., Chicago, Ill. **Circle 416**

Moving Bolster Assembly

Available as either a single or double unit, this bolster is mounted on a traction unit which moves on wheels over tracks on a table extending from one side or the other of the press. The traction unit is driven by a d-c motor and separate gear reducer which is designed to slow the motion of the bolster as it approaches the positive stops. Hydraulic cylinders raise and lower the bolster to and from the bed. Double units utilize extension tables on both sides of the press and two traction units with bolsters connected in tandem. When one bolster is in pressing position, the other bolster is on the extension table where tooling changes can be made while the other bolster is in use.



Verson Allsteel Press Co., 9300 S. Kenwood Ave., Chicago, Ill. **Circle 417**

Shearing, Forming and Piercing Machine

Model TE-150 shearing, forming and piercing machine cuts in the center of 0.150-inch mild steel plate without a starting hole. It has an edge cutting capacity of 8-gage mild steel plate, 11-gage stainless steel and 5-gage copper and it can cut to either a scribed line or to a template. The 42-inch throat depth permits circle cutting up to 40-inches diam inside the throat.

Other features include a stroke adjustment with a positive stroke scale, a cam action that provides vibrationless

DIAMOND WHEELS by Carborundum are most economical for carbide tipped cutter grinding. Many in-plant tests conducted on the grinding of carbide tipped cutters have proved Carborundum Diamond Wheels superior to competitive wheels in economy and grinding performance. The efficiency and savings indicated by the results of these tests are so outstanding that the details of many of them have been forwarded to Carborundum distributors and salesmen for your reference. Ask the Carborundum representative in your area to show you these facts on his next call. **CARBORUNDUM**®

interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1-½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures . . . and is also adaptable to the use of low pressure oil as the working medium. Write today to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

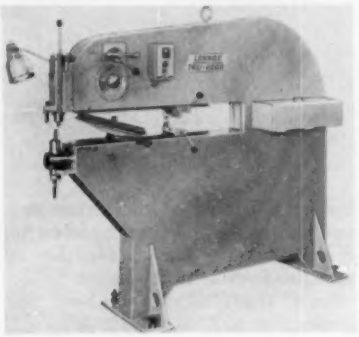
CHECK THESE 10 POINTS OF T-J SUPERIORITY

1. One Piece Piston
2. Hard Chrome Cylinder Bore and Piston Rods
3. High Tensile Steel Tie-Rods
4. Cushion Adjusting Screw, Externally Adjustable
5. New Super-Cushion for air, or Self-Aligning Master Seal for oil (T-J Patents)
6. Solid Steel Heads and Mounting Plates Standard all Models
7. Port Design Allows Minimum Pressure Drop on Inlet or Outlet
8. Chevron Type, Self-Adjusting Rod Packing
9. Piloted Packing Gland—Absolute Alignment
10. Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON
RIVETORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

Use Reader Service Card, CIRCLE 46

operation, a drive mechanism of five moving parts and an adjustable bottom shearing die. The machine operates with a reciprocating upper tool and stationary lower tool. It has an infinite range of stroke lengths from 0.032 to 0.145 inch with strokes per minute (in relation

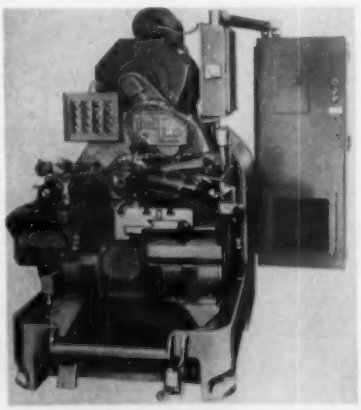


to material thickness) being automatically regulated when setting stroke length. Maximum cutting speed is 36 fpm with number of cuts per minute ranging from 1750 to 3500.

Lennox Tool and Machine Builders, Lima, Ohio. **Circle 418**

Chucking Machine

Designed primarily for second operation work, the Chuck-T-Matic single-spindle chucking machine features a variable speed d-c motor with automatic controls to vary the spindle speed. Dual tracer attachments perform two operations in selected sequence. There are

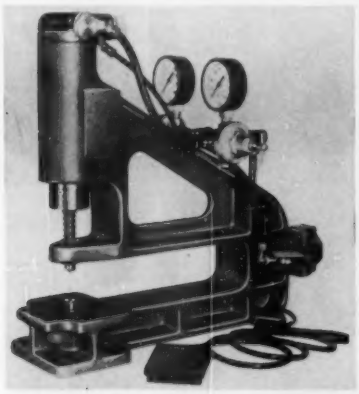


no cams or gears to change. Tracer templates position preset tools, automatically actuating controls to obtain spindle speeds for diameters from ⅞ to 9½ inches.

National Acme Co., 170 East 131st St., Cleveland 8, Ohio. **Circle 419**

Pressing and Staking Machine

The usual hand lever for pressing and hand release for staking are replaced with a single foot switch on the Press-

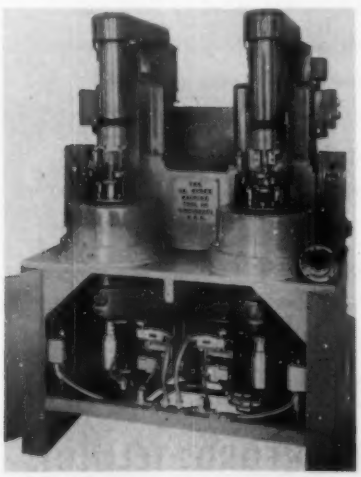


taker pressing and staking machine. Air at controlled pressure drives the ram downward to hold down the parts or secure a press fit. When the desired hold-down pressure is reached, an automatic valve releases compressed air to the staking punch inside the hold-down ram, completing the cycle. Hold-downs and stakes are interchangeable for a wide range of work requirements and both the hold-down pressure and staking force are independently adjustable.

Cramer Controls Corp., Centerbrook, Conn. **Circle 420**

Oil Groove Milling Machine

Two parts are processed at one time on the duplex vertical half-mill. Developed for high-production rotary milling operations, this machine has two independently powered rotary tables



(Continued on page 119)

which revolve at 2 rpm. It is equipped for automatic cycling. It can mill circular grooves, such as oil grooves, to preplanned tapered depths.

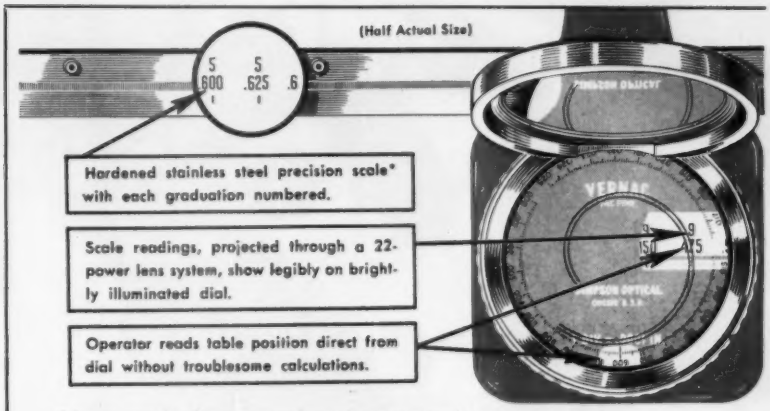
U. S. Burke Machine Tool Co., Cincinnati 27, Ohio. **Circle 421**

Second Operation Machine

Model DSM59-R second operation machine provides a 1 1/16-inch round collet capacity through the spindle, step chuck capacity to six inches, a 9-inch diam swing over bed and spindle speeds to 4000 rpm. Among its features are a

self-contained driving unit, preloaded ball bearings, an electric interlock for

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODY INFORMATION


(Half Actual Size)
Hardened stainless steel precision scale* with each graduation numbered.
Scale readings, projected through a 22-power lens system, show legibly on brightly illuminated dial.
Operator reads table position direct from dial without troublesome calculations.

New optical measuring instrument assures . . .

high operating accuracy for new or used machine tools

The new VERNAC Direct Reading Optical Measuring Instrument eliminates the complexities of using end rods and gage blocks. Now, the longitudinal, lateral or vertical positioning of machine tool tables can be quickly and easily read direct to .0002". Accuracy is not affected by the wear or stretch of table movement screws. The instrument itself has no moving parts which can impair accuracy.

VERNAC instruments also up-grade machine tools to perform tasks beyond their original accuracy. For example, they can up-grade moderately priced milling machines to the accuracy of more expensive jig boring machines at a fraction of the latter's cost.

*The scale is a replica of a master certified by the U.S. National Bureau of Standards to .0001" maximum error over its entire length.

SEND FOR FREE BULLETIN. Explains how the VERNAC enables you to do more precise work on your present machine tools.

VERNAC® UNITED STATES AND FOREIGN PATENTS PENDING

Designed and Manufactured by
SIMPSON OPTICAL MANUFACTURING CO.
3202-04 Carroll Ave., Chicago 24, Ill.

Manufacturers and designers of precision optics for scientific equipment since 1926.

0720

Simpson Optical Manufacturing Company, 3202-04 Carroll Ave., Chicago 24

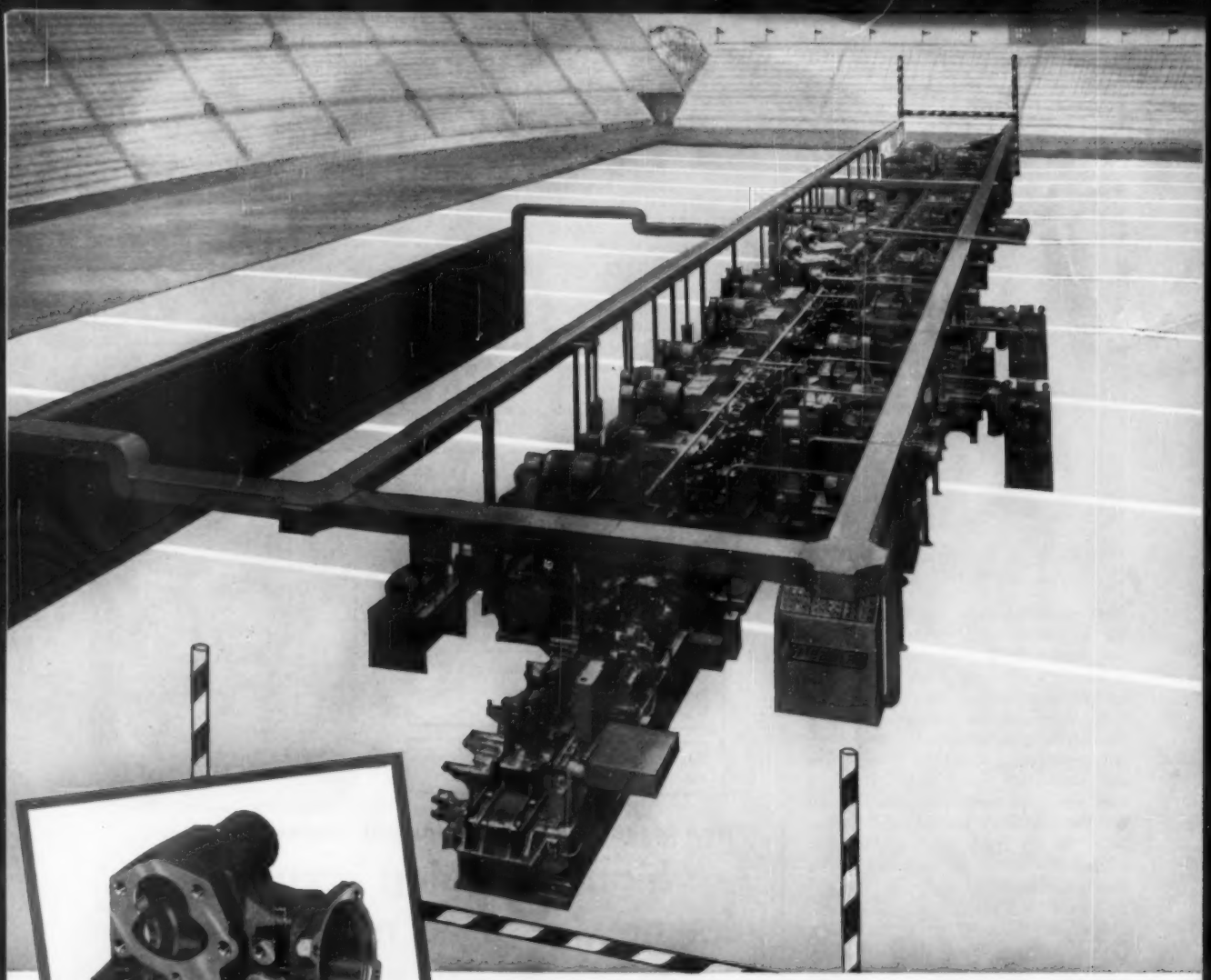
Send me free literature describing the VERNAC Optical Measuring Instrument.

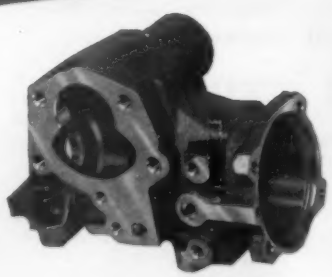
Name

Company

Street Address City Zone State

Use Reader Service Card, CIRCLE 47





HYDRAULIC STEERING
GEAR HOUSING

OPERATIONS:
8 - Milling
30 - Boring
40 - Drilling
4 - Recessing
24 - Chamfering
24 - Tapping
32 - Checking

PRODUCTION MACHINERY
GREENLEE

"MACHINES DESIGNED WITH THE FUTURE IN MIND"

300 FEET LONG . . .

completely set up and tested before shipment

Greenlee's manufacturing facilities have expanded to keep pace with customer requirements for mechanized production equipment. Complete transfer machines are production proven on our assembly floor before delivery. Test runs are made with coolant supplied from a central system built into the assembly floor. Actual production is simulated except that test run parts are subjected to 100% inspection . . . customer changes are made more readily and economically. This careful testing and thorough inspection pays off after installation . . . gets you into full production faster. Let a Greenlee representative give you the facts and figures.

TRANSFER MACHINES • SPECIAL MACHINES • SIX AND FOUR SPINDLE AUTOMATICS • DIE CASTING MACHINES
TRIM PRESSES • WOODWORKING MACHINES AND TOOLS • HYDRAULIC AND HAND TOOLS

GREENLEE BROS. & CO. 1928 MASON AVE. ROCKFORD, ILLINOIS

Ed: This looks good to me - let's discuss it - JB.

Use Reader Service Card, CIRCLE 48

Use THESE HANDY FORMS

to obtain more TOOL and MANUFACTURING

INFORMATION

about Products covered

in this issue of

The Tool and Manufacturing Engineer

PRINT—DON'T WRITE

Circle KEY NUMBER —each item carries a Key Number.

Print clearly your name, title, firm name, product manufactured and your company address.

NO POSTAGE REQUIRED
Just Tear Out and Mail

Copies of Technical Articles are available upon written request —as long as the supply lasts.

FIRST CLASS
PERMIT NO. 10782
DETROIT, MICH.

BUSINESS REPLY MAIL
No postage stamp necessary if mailed in the United States.

The Tool and Manufacturing Engineer

10700 Puritan Avenue

Detroit 38, Michigan

December 1960 *Send Me FREE* **INFORMATION** *on CIRCLED NUMBERS*

Name..... Title.....

Company..... Product.....

☐ Co. Address..... ☐ Residence

City..... State.....

EDITORIAL TOOLS OF TODAY INFORMATION

401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420
421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440
441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460
461 462 463 464 465

EDITORIAL TRADE LITERATURE INFORMATION

501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520
521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540
541 542 543 544 545 546 547 548 549 550 551

USE CARD ON REVERSE SIDE FOR ADVERTISING INFORMATION

USE THESE HANDY FORMS

to obtain more TOOL and MANUFACTURING

INFORMATION

about Products covered

in this issue of

The Tool and Manufacturing Engineer

December 1960 *Send Me FREE* **INFORMATION** *on CIRCLED NUMBERS*

Name.....Title.....

Company.....Product.....

☐ Co. Address..... ☐ Residence

City..... State.....

ADVERTISING INFORMATION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	

TOOL CRIB SECTION INFORMATION

601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617

COVER ADVERTISERS' INFORMATION

☐ Inside Front Cover 102 ☐ Inside Back Cover 103 ☐ Back Cover 104

Send me information on products, catalogs or articles featured on page .....

Advertiser's name or product .....

USE CARD ON REVERSE SIDE FOR EDITORIAL INFORMATION

PRINT—DON'T WRITE

Circle KEY NUMBER —each item carries a Key Number.

Print clearly your name, title, firm name, product manufactured and your company address.

NO POSTAGE REQUIRED
Just Tear Out and Mail

Copies of Technical Articles are available upon written request —as long as the supply lasts.

FIRST CLASS
PERMIT NO. 10782
DETROIT, MICH.

BUSINESS REPLY MAIL
No postage stamp necessary if mailed in the United States.

The Tool and Manufacturing Engineer

10700 Puritan Avenue

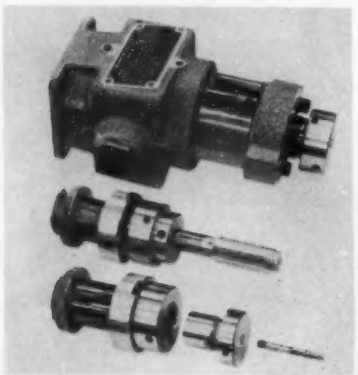
Detroit 38, Michigan

the spindle lock pin and coolant facilities with a self-draining pan. The double cross slide takes standard tooling accessories for forming, cutting off, facing and taper turning operations.

Hardinge Brothers, Inc., Elmira, N. Y. **Circle 422**

Tapping Head

Especially suited for tapping tough materials and blind holes, the Leadmatic leadscrew tapping head is furnished with a timer that allows tapping to depth and tap retraction for the hole. The drive runs in ball bearings and multiple tooth positive jaw clutches al-



low forward and reverse motions. The leadscrews are interchangeable for threads from ⅛ to 1 inch diam. This unit is for use on single-spindle equipment.

Burg Tool Mfg. Co., Inc., 15001 S. Figueroa St., Gardena, Calif. **Circle 423**

Port Contour Cutters

Machining hydraulic fittings in one pass to any standard specification can be performed by these port contour cutting tools. The contour of the internal diameter of such fittings involves

a combination of up to four diameters, two radii, two angles and a surface spotface. Each diameter, radius and angle is machined in relationship to the others to critical size, depth and smoothness tolerances. Either a conventional cutter grinder with locating finger or an

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

ALLEN

The cost of ALLEN Hex-Socket Cap Screws is only a minor fraction of your assembly costs . . . be sure you're getting the timesaving, cost-saving advantages of genuine Allens!

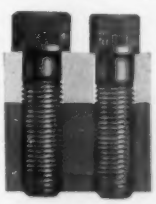
Ever since Allen first produced the hex socket head screw nearly fifty years ago, specifying *genuine* Allens (made by Allen of Hartford) has been a sure way to guarantee dependable threaded fastening.

Only *genuine* Allens have Leader Points that make starting easier, and greatly minimize danger of cross threading. *Genuine* Allens are "pressurformd" to preserve the long fibers uncut throughout the length of the screw, giving stronger sockets for greater tightening torque.

Write for samples and engineering data. See how *genuine* Allens will make your product better.

ALLEN HEAD HEX-SOCKET SCREWS

Allen's new 1960 Series Socket Head Cap Screws give up to 2½ times more load carrying capacity, without indentation. Head diameter of sizes from ¼" up is now uniformly 1½ times the body diameter—providing more under-the-head bearing surface, and a proportionate increase in clamping force. Write for new Bulletin G-25, with full specifications.



Stocked and sold by leading Industrial Distributors everywh

50 ANNIVERSARY YEAR ALLEN HEAD 1910-1960

ALLEN MANUFACTURING COMPANY

HARTFORD 1, CONNECTICUT, U.S.A.

Use Reader Service Card, CIRCLE 51

AMERICAN

Please

American Twist Drills are not readily available—The American Automotive Industry demands practically all capacity for precise, uniform mass production requirements. Eventually they will be available to all industry through selected Industrial Distributors.

Brown & Sharpe CUTTING TOOLS

American Twist Drill Co.
Detroit, Michigan
Subsidiary of
Cutting Tool Division
Brown & Sharpe Mfg. Co.,
Providence 1, Rhode Island

AMERICAN

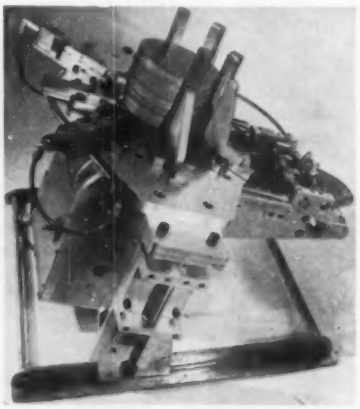
TOOLS of today

automatic indexing cutter sharpening machine can be used to sharpen the index-notched ground form-relieved flutes. Two head styles are available. one having pilots or reamers for concentricity of tapped holes and profiles and the other having replaceable pilots or reamers.

Metal Cutting Tools, Inc., Dept. 1066. Rockford, Ill. **Circle 424**

Press Feeder

This automatic press feeder separates polished or oiled metal parts without damaging or marring the part edge or surfaces and without affecting operating speeds at rates up to 150 parts per minute. Separation occurs through lateral and horizontal movement of the bottom blank of a top-load magazine. An adjustable speed conveyor guides the blank into the die nest. Offered in



various models for parts from 1½ to 16 inches diam, each feeder size is adjustable within a range of four inches. Feeder action is provided by a closed circuit hydraulic system which is cam-actuated by a chain drive from the press crank. The feeder is applicable to any make or model press.

Clark Industries, Delaware, Ohio. **Circle 425**

Adjustable Go-Not Go Gage

This go-not go gage has two pairs of independently adjustable, oppositely opposed and spring-loaded gaging arms. One pair of arms can be set for a given "go" dimension and the second pair, for a "not go" dimension. The gage is intended for checking the ID's and OD's of face grooves, ring grooves and O-rings, as well as thread reliefs and slots. Capacity is five inches with the arms set

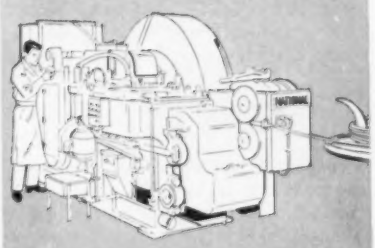
Use Reader Service Card, CIRCLE 52

BOLTMAKERS make these interesting parts, and countless others, every day from wire.

Operations include cutting off, extruding, heading, trimming, pointing and thread-rolling.

It's just possible *your* metal parts can be made faster, stronger and at lower cost in Boltmakers (or in other types of Nationals).

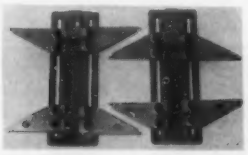
May we help you investigate?



NATIONAL ½-INCH BOLTMAKER
4,200 PARTS PER HOUR!

NATIONAL MACHINERY CO.
TIFFIN, OHIO, U. S. A.
HARTFORD DETROIT CHICAGO

Use Reader Service Card, CIRCLE 53

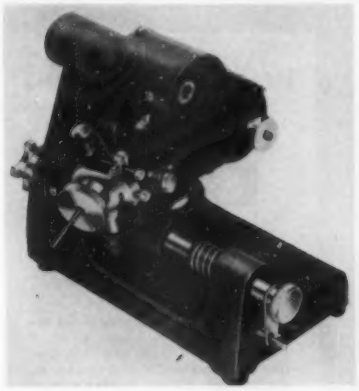


as shown on the left side of the photograph and three inches when set as shown on the right.

Speed Tool Co., 1144 N. LaBrea Ave., Los Angeles 38, Calif. **Circle 426**

Cutter Grinder

A bench type model, the cutter grinder can be used for grinding all engraving cutters used on pantograph



machines and all two-lip milling cutters. It has an automatic setting for angular and clearance uniformity which can be preset for repetitive duplications of a given angle or clearance. It is constructed to allow tip grinding with the cutter remaining clamped in the toolhead. The toolhead, capable of handling cutters up to ½ inch, is calibrated to 180 deg in angular adjustment. The cutter feed dial is graduated to 0.001 inch.

New Hermes Engraving Machine Corp., 154 W. 14th St., New York 11, N. Y. **Circle 427**

Drilling Unit

Model 300 air-powered and hydraulically controlled automatic drilling unit has a 3-to-1 thrust and a 3-inch stroke. It is capable of drilling holes up to ½-inch diam in cast iron. Both the air-power thrust and the hyraulic counterthrust are applied along the centerline of the quill, eliminating deflection of the quill encountered when the thrust or counterthrust are applied off center. The air and hydraulic cylinders are

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Easy Operation, Precision Measurements ...with Wilson "Rockwell" Hardness Testers

• No matter what your hardness testing requirements are, there's a Wilson Rockwell instrument to do the job easily and accurately. Long recognized as the world's standard of hardness testing accuracy, Wilson instruments on the production line and in the laboratory offer these advantages:

Accuracy—Each instrument is precision-built, with exact calibration, for consistently correct results.

Easy operation—Even an unskilled operator can get perfect readings. All controls conveniently grouped.

Long life—Simple design, rugged construction make Wilson instruments as durable as a machine tool.

Easy maintenance—Interchangeable mechanisms, with spindles mounted in oil-less bearings.

Complete line—Choose from the widest variety of instruments available, including semi and fully automatic models.

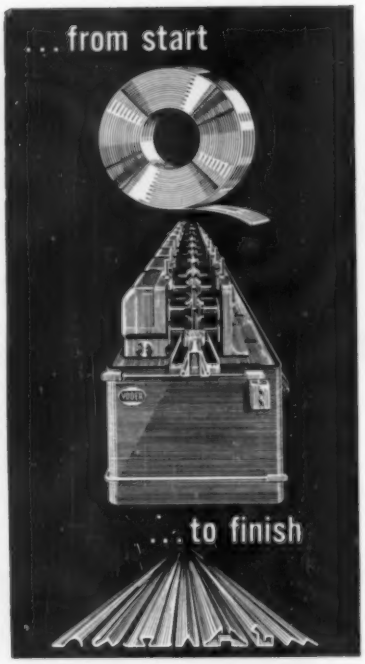
Wilson "Brale" Diamond Penetrators Each diamond is cut to an exact shape. A comparator check and microscopic inspection of each diamond assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the Superficial tester as well as on the full line of Wilson Rockwell hardness testers.

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-H Park Avenue, New York 17, New York
Use Reader Service Card, CIRCLE 54

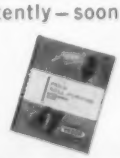


YODER ROLL-FORMING EQUIPMENT

Profits are available to you through the production of many shapes in metal... made with precision and economy on Yoder Cold Roll Forming Equipment.

Produce tubular, ornamental or structural shapes from a variety of metals in widths from a fraction of an inch up to 80 inches or more, and in stock up to ¾" thick. Your investment is comparatively modest, and with proven low operating costs, will give you one of the most profitable operations in your plant.

Experienced Yoder engineers will, without obligation, study your annual metal forming requirements. Many times they can point out that the installation of roll forming equipment would—even if operated only intermittently—soon justify its initial cost.



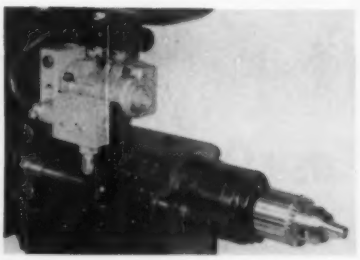
Send today for this comprehensive, 88-page illustrated text. It fully describes Cold Roll Forming Equipment, processes and products.

THE YODER COMPANY
5525 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING
COLD ROLL FORMING MACHINES

Use Reader Service Card, CIRCLE 55

TOOLS of today

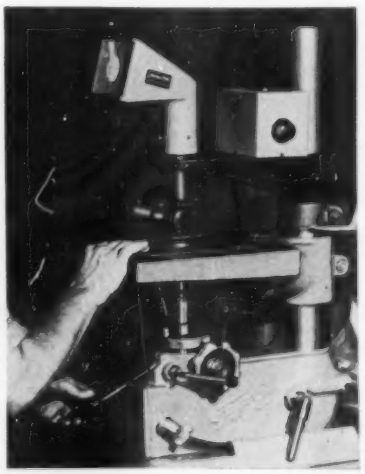


divided into two parts which, in the hydraulic cylinder, eliminates the need for a separate sump and valving to keep the cylinder completely filled. Spindle speeds up to 8000 rmp are possible and the unit is powered by a standard foot mount motor. Over-all length, including three-step pulleys and belt guard, is 15¾ inches.

Govro-Nelson Co., 1931 Antoinette, Detroit 8, Mich. **Circle 428**

Optical System for Drilling Holes

Designed for drilling holes in printed circuit boards, this system consists of a Model No. 33 optical package (power supply, condensing system, front surface illuminator, projection system, hood and screen assembly), a stand and a drill. The optical projector is mounted on an arm which can be traversed on



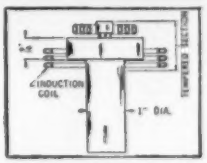
a vertical column for focusing. The worktable has a drill bushing mounted to its underside and a rocker clamp secured to its top. Beneath the table the drill is mounted vertically. The drilling unit and the clamp can be controlled manually or by a foot-actuated cam. In operation, the drill point is lined up on the crosshairs of the projector screen.

LepeL

HIGH FREQUENCY INDUCTION **HEATING UNITS**

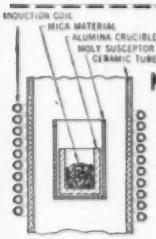
Lepel induction heating equipment represents the most advanced thought in the field of electronics... the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS



Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



Heating Non-Conducting Materials To High Temperatures

Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw
Spark Gap Converters from 2 Kw to 30 Kw.

LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.
Chicago Office — 6246 W. North Ave.

Use Reader Service Card, CIRCLE 56

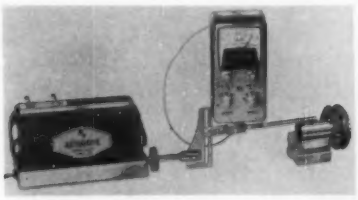
The printed circuit board is placed on the work surface of the table under the projector. The hole location dots are projected on the screen and lined up in the center of the cross lines, which are already lined up in position with the drill. A foot control is actuated to clamp and drill the board.

Magnifications of 10x to 100x are available. At 100x, accuracy to 0.0001 inch is possible.

Stocker & Yale, Inc., 44 Green St., Marblehead, Mass. **Circle 429**

Surface Roughness Tester

Roughometer SR-14 is a portable instrument for measuring the surface roughness of metal or plastic parts. Its battery-operated amplifier consists of a feedback stabilized tube and transistor



circuit. Two holders are provided, enabling the pickup to be used both for measuring the roughness of holes ¼-inch diam or larger and outside surfaces having a diameter of $\frac{1}{32}$-inch or larger.

A mechanical tracer for the Roughmeter, Autodrive Model SR-13 provides a reciprocating mechanical motion of 0.032 to 0.9 inch in length. A 10-inch extension attachment, reversal bar and angle bracket make it possible to measure the surface roughness, deep holes and other surfaces that are difficult to reach. Its power requirement is 15 watts, 115 volts and 60 cycles.

Marduth Products, 1387 Ledge Rd., Hinckley, Ohio. **Circle 430**

Internal Recessing Tool

The Intramatic recessing tool, because it pilots directly in the part, can be used

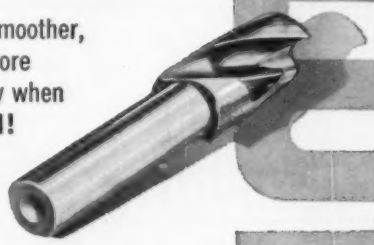
with any machine tool without special fixturing. It is capable of recessing wide face or multiple form grooves in any position regardless of remoteness from the entry face. It can back spotface to a maximum diameter of two times the

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

MILLING ALUMINUM

The best way to cut **ALUMINUM**, is with CARBIDE!

Carbide cuts faster, smoother, cooler and is much more economical, especially when milling **ALUMINUM!**



NELCO manufactures 121 different, "standard", off-the-shelf End Mills engineered for milling **ALUMINUM!**

ALUMINUM is a relatively soft material but it is one of the most abrasive.

Cutting tools that are not designed to mill **ALUMINUM** can make production very expensive.

NELCO manufactures the most complete variety of Carbide Cutting Tools, engineered to mill **ALUMINUM** and they are available through your Local Distributor.

(Send for Catalog Today.

More End Mill Production . . . Less Initial Cost

Save 20% with THRIFTMILLS®

For that EXTRA Edge in Production!

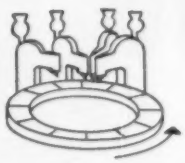
NELCO

NELCO Tool Co., Inc.
Subsidiary of:
Cutting Tool Division
Brown & Sharpe Mfg. Co.
Providence 1, Rhode Island

Use Reader Service Card, CIRCLE 57

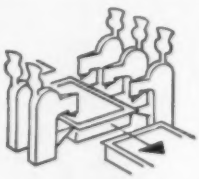
A FEW OF MANY POSSIBLE RIVETING HEAD POSITIONS THAT CAN BE USED

Rotating fixture showing suggested arrangement of riveting heads.

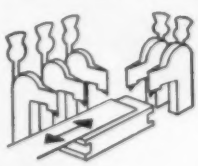


Riveting heads can be positioned for fastening on flat or curved assemblies.

Conveyor Belt permits multiple setting on both sides of an assembly.



Sliding fixture used for riveting 2 sides of an assembly.



AUTOMATE RIVET SETTING

for new low costs

For years assemblies made of metal and non-metal or a combination of both have been fastened most economically with semi-tubular rivets. And now even lower costs are possible with the thin-nose riveting heads designed by Chicago Rivet. These heads, pneumatically operated but electronically controlled, can be grouped in clusters on one or more planes and will set rivets as close as 13/16" apart. Automation, thru rotating sliding or continuous belt feeding and riveting stations, is possible. Riveting heads may be repositioned and used again on new assemblies.

CUSHIONED RIVETING REDUCES BREAKAGE

A pneumatic riveter upsets the rivet with a squeezing action which minimizes breakage and automatically compensates for slight variation in assembly thicknesses.

The suggestions of Chicago Rivet fastening specialists will prove most helpful. Call them—no obligation.

AIR-POWERED RIVETING CATALOG contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automation.

RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

Chicago Rivet **& MACHINE CO.**

960 So. 25th Ave., Bellwood, Ill. (Chicago Suburb) - Branch Factory: Tyrone, Pa.

Use Reader Service Card, CIRCLE 58

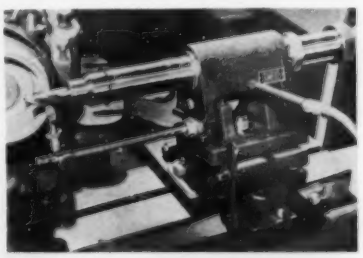
TOOLS of today

hole diameter. This model, JA, will accommodate holes from ¼ to 2 inches and a larger model is available for holes to 6 inches diam.

Nobur Mfg. Co., 6860 Farmdale Ave., North Hollywood, Calif. **Circle 431**

End Mill Sharpening Fixture

Straight-shank end mills from 3/16 to 1¼-inch diam can be sharpened, by means of a matched bushing set, with this fixture. The fixture, which mounts directly on the table of any make tool



grinder, consists of a sub-base, rocking head, finger-arm assembly and an air-spindle assembly. It is supplied with the necessary servicing tools.

Weldon Tool Co., 3000 Woodhill Rd., Cleveland 4, Ohio. **Circle 432**

Numerically Controlled Dividing Table

The Rotoptic 6A optical dividing table is numerically controlled either by punched tape or with manual input. It is provided with an automatic optical indexing system. Full degrees and one-

sixth degrees are read on the peripheral graduation of the platen, minutes and seconds of an arc on the divided drum. Fine setting of the platen is made by centering the image of the built-in master circle appearing in the ocular field of the microscope within the double line

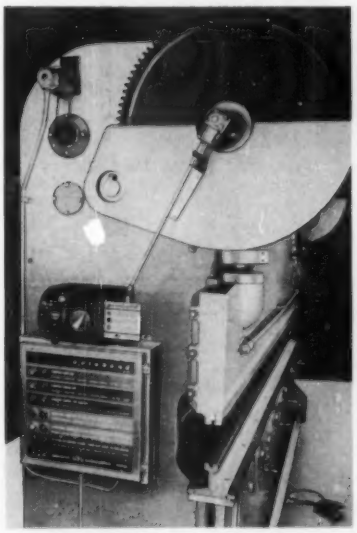
USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

of the reticle. The unit is powered by two motors—a squirrel-cage motor for rapid rotation of the platen and a servo-motor for final automatic indexing.

American Sip Corp., 100 E. 42nd St., New York 17, N. Y. **Circle 433**

Pushbutton Control

Autobend BC-100, a pushbutton control unit, can be attached to any size and model press brake. Features of this unit are pushbutton programming for many types of production and custom work; automatic bending; stepless



speed control from a small fraction to 100 percent; easier handling of long and troublesome pieces; and two-operator control of any operation, when desired.

General Automation Corp., 40-66 Lawrence St., Flushing, N. Y. **Circle 434**

Small Hole Drilling Unit

Model 113-3½ small hole drilling unit has a 3½-inch stroke. It also has an electric motor spindle and air feed with hydraulic control. Spindle speeds from 750 to 15,800 rpm are possible. Chuck capacity is ¼ inch.

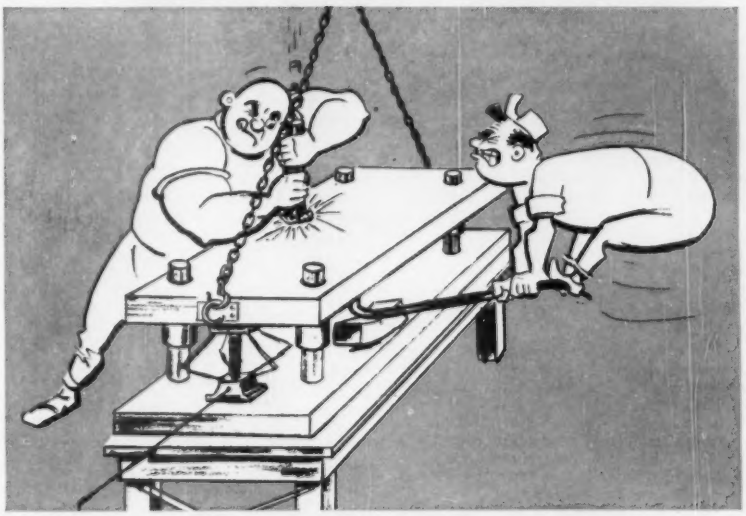
Electro-Mechano Co., 241 E. Erie St., Milwaukee, Wis. **Circle 435**

Ball and Cylinder Measuring Attachment

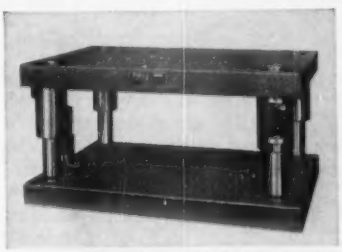
Designed for use with Model 214 Fringecount Micrometer, this ball and cylinder measuring attachment consists of an anvil, soak plate and a set of interchangeable rotating stops which are mounted on the soak plate and used to locate the part under the contact point of the measuring head. These stops provide adjustment for the measurement of balls and cylinders from 0.062 to one-inch diam in steps of 0.062 inch. The attachment is an electrooptical

measuring instrument, utilizing light as its standard of measurement and incorporating an electronic readout system. Accessory equipment includes holding

DON'T KNOCK YOURSELF OUT WITH STICKY DIE SETS!



Dieco Ball Bearing Die Sets take all the strain out of die making!



NO PAIN...NO STRAIN...and it is extremely accurate! These precision die sets give you burr-free parts and longer production runs – thanks to their "negative clearance." (Cutaway shows how ball-bearing bushing rides on the pin.)

Try a Dieco ball-bearing die set on that next job; you will actually see the punch holder g-l-i-d-e on and off. Folks tell us working with Dieco is almost like taking a two-week vacation. It's that easy.

Management likes them, too. The pre-loaded bushing eliminates die shifting, protects the dies, and gives longer runs between grinds. These sets are assembled in the conventional way; pins are in the shoes. We will sell you complete sets, or just the components, so you can convert the friction bushing sets you now have.

dieco DIE SETS

E. W. BLISS COMPANY
DIE SUPPLY DIVISION
1400 Brookpark Road
Cleveland, Ohio

Use Reader Service Card, CIRCLE 59

Gaertner Toolmakers' Microscope used to measure typical piece part. Co-ordinate range 4" x 2".

Precise measurement to 0.0001" and 1 min. of arc

Gaertner Toolmakers' Microscope

Here is a reliable, easy-to-use microscope for precise measurement of piece parts, tools, dies, thread gages, templates, jigs, fixtures, etc. Ideally suited for making a wide variety of precision measurements and is especially valuable in reducing rejects in production work.

With the Gaertner Toolmakers' Microscope you make direct, non-destructive measurements — no contact, no distortion, images are sharp and clear. It is a basic measuring instrument for inspection depts., gage labs, tool and die and model shops, industrial and research labs.

The Gaertner Toolmakers' Microscope has been proven in use by U. S. Government Gage Laboratories, and by prime contractors and their subcontractors. With all parties using the same measuring instrument, inspection procedures are co-ordinated and disagreements and rejects minimized.

Features that help you get
HIGH SETTING AND REPEATING ACCURACY

- Low, compact built-in rotary stage reads to 1 minute of arc throughout 360° range.
- Minimum overhang of stages.
- Full 2" precision-lapped lead screws with correction device.
- Straightforward, direct, uncomplicated optical system.

Features that assure you of
EASY, CONVENIENT OPERATION

- Independently rotatable cross hairs in protractor ocular speed up measurements, simplify measuring procedure.
- Convenient location of ocular eyepieces for ease of reading.
- Built-in transformer and plugs for all illuminators.

Modifications and accessories to
MEET YOUR EXACT REQUIREMENTS

- Thread and radius templates, camera and spotting attachments, fine motion focus, variable magnification available.
- If you have a special measuring problem, our staff of representatives will be happy to consult with you. The service and engineering facilities of the manufacturer are always immediately available to help you.

Write for Bulletin 147-56
Designed and manufactured by

The Gaertner Scientific Corporation
1241 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

Use Reader Service Card, CIRCLE 60

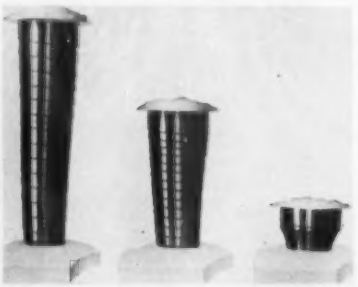
TOOLS of today

tools and a lapping plate. Also included are correction tables for deformation of steel balls, flats and steel wire type plug gages.

Link Div., General Precision, Inc., Binghamton, N. Y. **Circle 436**

Protective Covers

Elasticone covers—cone-shaped, spring-like devices—guard parts from dust, chips, nicks and scratches. These self-aligning and self-adjusting covers also prevent contamination of lubri-



cants. They are available in steel and copper in sizes from 4 to 60 inches in length.

Elasticone Div., Central Safety Equipment Co., 6601 Marsden St., Philadelphia 35, Pa. **Circle 437**

Hole Finishing Tool

Roll-A-Finishing, a modification of the bearingizing process, reduces 80 to 200-microinch surfaces to ±0.0002 to ±0.0025 tolerances and 2 to 10 micro inch finishes. When the tool enters the hole, tapered rolls ride up an inversely tapered mandrel, increasing tool OD and exerting a predetermined rate of

pressure. On passing through the work, the rolls glide down the mandrel to permit a free return stroke. Available sizes range from ½ to 2-inch diam.

Cogsdill Tool Products, Inc., 12980 W. Eight Mile Rd., Oak Park 37, Mich. **Circle 438**

Air Cylinders

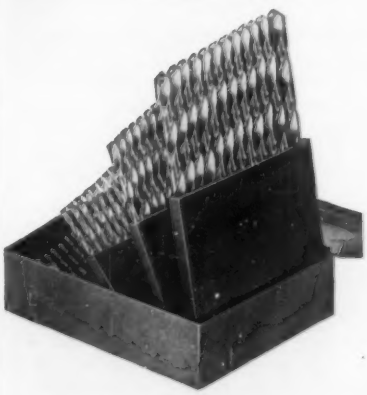
Series B one-inch-bore air cylinders were designed especially for high-speed machines and other applications where compactness is necessary. They employ self-lubricating Teflon piston seals and rod-seal wiper combinations and are rated at 200 psi. The rod seal-

Hardened, Tempered and Ground-from-the-Solid!

It pays to specify

ACE
DRILLS
REAMERS
BLANKS

Premium Quality High Speed Steel, Solid Carbide and Carbide Tipped.



ACE DRILL SETS
Standard stock sets include Fractional, Wire and Letter size drills, packaged in convenient folding index cases.

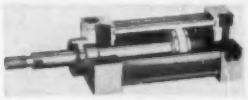
ACE BLANK SETS
Uniformly hardened high speed steel reamer and drill blanks precision ground to new close tolerance limits available in standard Fractional, Wire and Letter series sets.

Call your local distributor today—or write Ace direct for latest catalog and price information.

ACE DRILL
Adrian, Michigan
ORIGINATORS OF "GROUND-FROM-THE-SOLID" DRILLS

Use Reader Service Card, CIRCLE 61

wiper combination and leakproof barrel seals can be removed without disassembling the cylinder. Eight standard

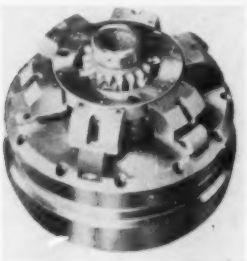


strokes ranging from ½ to 5 inches are available, with front flange, rear flange, trunnion, clevis or foot mountings.

Hydro-Line Mfg. Co., Rockford, Ill. **Circle 439**

Spring-Jaw Gear Chucks

Because they have automatically self-compensating spring jaws, these chucks give accurate gear location from all segments, even though the gears are out-of-round. Each jaw operates independently. Chucks for pneumatic,



drawbar or manual operation are available. By changing the cage and locating pins, the chucks can be adapted to handle a wide variety of gears.

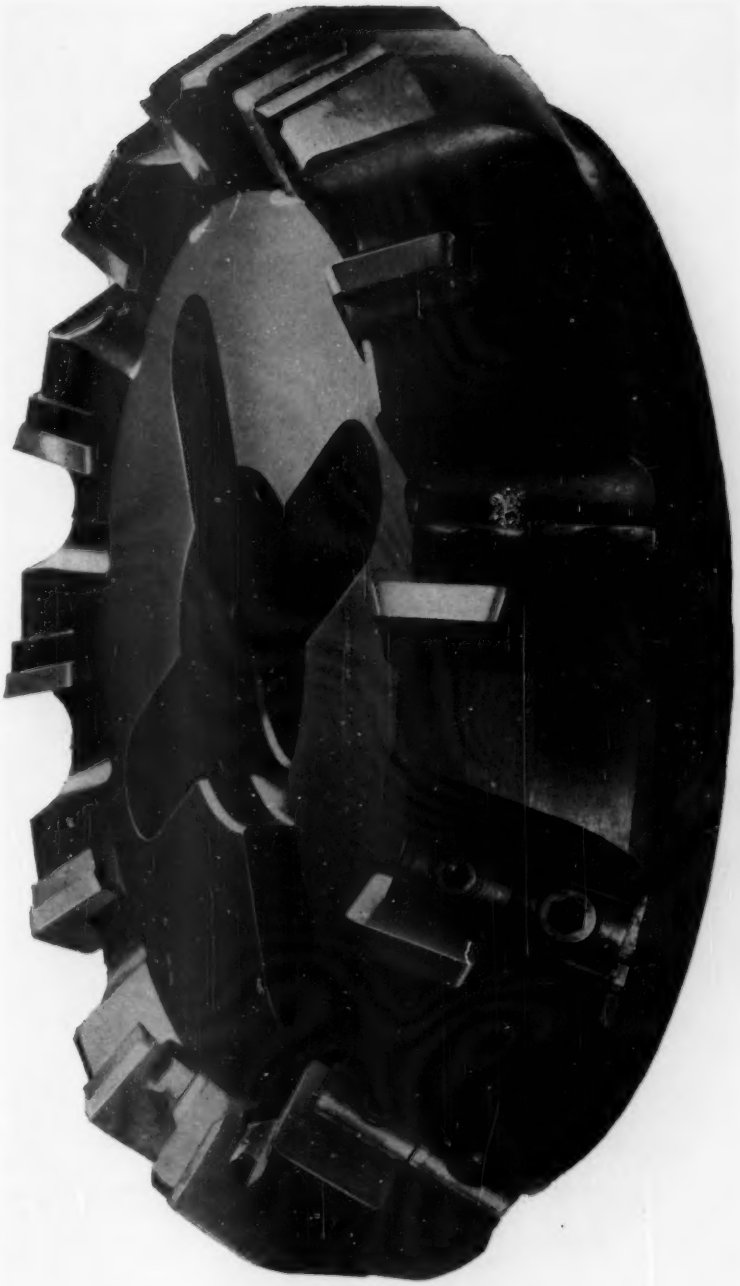
Erickson Tool Co., 34350 Solon Rd., Solon, Ohio. **Circle 440**

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Machinery Mount

Cold headers, shapers, die-casting machines, horizontal compressors and other machines whose operation de-

velops predominantly horizontal forces can be mounted on the Series RM mount for isolation of shock and vibration. The equipment rests on a top plate that



How efficient are Joydex cutters? We quote from a recent performance report: "Facing and rough milling a chrome-moly vanadium casting (Brinell 250) to a depth of ⅞" at cutting speed of 200 SFPM, the 12" dia. Joydex milled approximately 300 cu. in. per blade edge. Performance was beautiful."

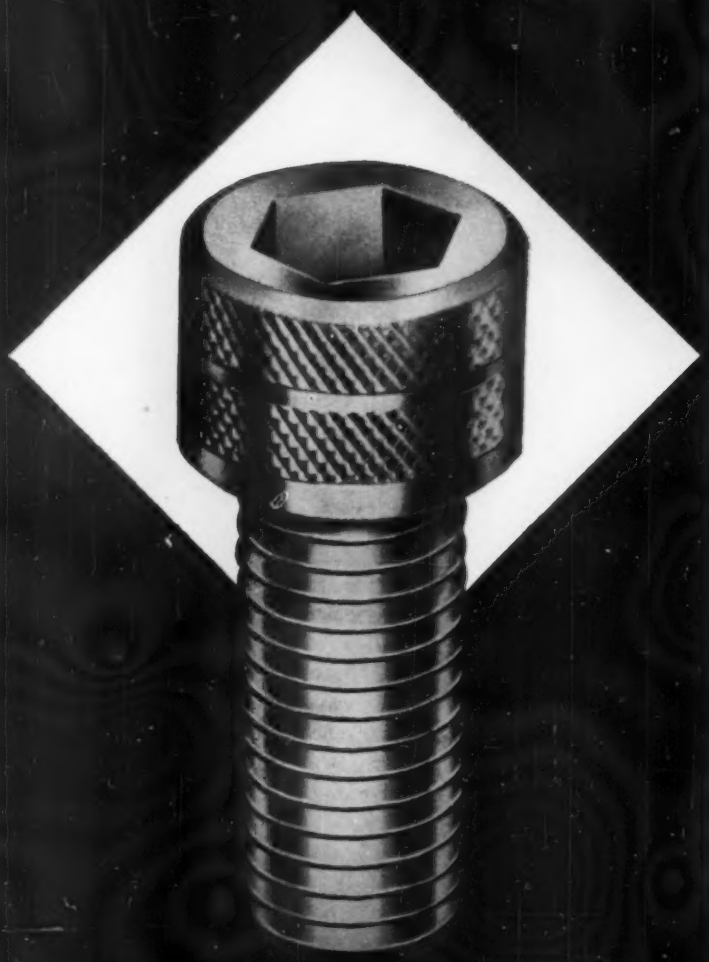
Send for "Joydex" Catalog.

LTC **LOVEJOY TOOL COMPANY, INC.**

Springfield, Vermont, U.S.A.

Use Reader Service Card, CIRCLE 62

Are you designing to series 60 standards? If so, specify Bristol.



This DOUBLE-DIAMOND knurl marks the BRISTOL "Series '60"

. . . the cap screw that holds more . . . indents less . . . wrenches tighter than ever before . . . meets or exceeds all new "Series 1960" standards of Socket Screw Manufacturers' Committee. Of course, regular Bristol "Series 1936" standard screws are still available in hex or Bristol Multiple-Spline.

Precision socket screw manufacturers since 1913

*Made in sizes as small as No. 0 in Alloy Steel and Stainless Steel. Cap screws up to 1½" diameter.

THE BRISTOL COMPANY Socket Screw Division Waterbury 20, Conn.

Use Reader Service Card, CIRCLE 63

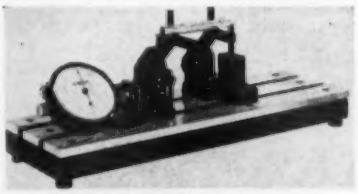
TOOLS of today

rides on a set of internal rollers and is laterally restrained by end-positioned neoprene springs. The mount, capable of handling 4000-lb static loads and measuring $10\frac{5}{16}$ x 8 x $1\frac{3}{8}$ inches, eliminates the need for special foundations and grouting or inertia blocks.

Barry Wright Corp., 700 Pleasant St., Watertown, Mass. **Circle 441**

Adjustable Length Gage

Adjustable for lengths from $\frac{5}{8}$ to 8 inches and for support on diameters from $\frac{1}{16}$ to $1\frac{1}{4}$ inches, this gage can check over-all, shoulder-to-end, shoulder-to-shoulder and other lengths. It is set up with gage blocks or a known-size

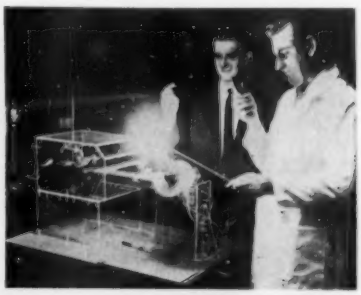


piece part. A reed transfer carries the measurement from the part to the dial indicator. Depending on the indicator model selected, either coarse or fine measurements can be made.

Unigage Corp., 330 Interstate Rd., Addison, Ill. **Circle 442**

Plasma Torch

The energy liberated in the form of heat when gas molecules are broken up and ionized into their component atoms and then recombined is the principle upon which this plasma torch operates. No fuel is needed. Applications for the

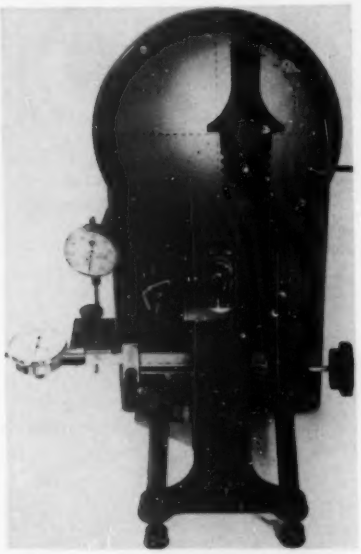


torch include spraying high-melting-point metals and ceramics, welding, etching, machining and chemical purification and processing. None of the torch parts become heated during use.

Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. **Circle 443**

Portable Optical Comparator

Weighing less than 25 lb, this portable optical comparator can be used anywhere in the shop. Its 8-inch screen has 20X magnification. The scale on the screen covers 0 to 180 deg, right and left. A vernier scale is marked in



5 min increments. The screen also has radius lines from 0.005 to 0.150 inch in 0.005-inch increments and staggered cross lines. The stage is 2½ x 9½ inches with a T-slot. Wall effect on flat surfaces is eliminated and a true, straight line can be projected to the edge of the screen without distortion with the color corrected objective lens.

Micro-Vu Sales Co., 6850 Vineland Ave., North Hollywood, Calif. **Circle 444**

Four-Way Valve

Having 30 gpm capacity, this solenoid-controlled, pilot-operated direction valve is equipped with Q-E-L solenoids that have four to five times the life of conventional air-cooled solenoids. The

unit is available with subplates having either 3¼-inch pipe thread connections for flows up to 20 gpm or one-inch connections flows above this figure.

Vickers Inc., Div. of Sperry Rand Corp., Detroit 32, Mich. **Circle 445**

Inert-Arc Welders

Available in 200, 300 and 400-amp models, the Murex inert-arc-welding machines have a gas afterflow device that eliminates the need for timers. A spark gap oscillator (with silencing circuit) produces high-frequency pulses for instant starting and arc stabilization. The transformer is of dust-coil construction, giving a high starting current and a high power factor. Cooling is by forced draft.

Automatic remote control of current, gas and water is provided by a switch that can be attached to the welding torch. At the end of a weld, gas afterflow continues for a preset period of time and then shuts off automatically.

Metal & Thermit Corp., Rahway, N. J. **Circle 446**

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Bending Machine

Offered in three models, this bending machine is designed for low-production

NOW—BETTER SURFACE FINISHES WITH MINIMUM PARTS PREPARATION
Roll-A-Finishing, cousin to Cogsdill's famous Bearingizing process, reduces 80 to 200 micro-inch surfaces to ± .0002 to ± .0025 tolerances and 2 to 10 micro-inch finishes. Special high speed equipment is not necessary; parts preparation is minimized since holes may be rough-bored to tolerances up to .005 before Roll-A-Finishing. Roll-A-Finishing exerts a steady rate of pressure against the work surface. The metal flows out ahead of the tool, filling microscopic valleys and leveling the peaks. Surface hardness is increased 5% to 10% with a penetration of .010 to .030. When the tool enters the hole, tapered rolls ride up the inversely tapered mandrel, increasing tool O.D., and exerting a predetermined rate of pressure. On passing through the work, the rolls glide down the mandrel to permit free return stroke. This tool is adjustable in increments of .0001 over a .041 range.
ROLL A-FINISHING
From rough bore to low micro-finish - - - in one pass!
For better finishes, get the Roll-A-Finishing story in the Cogsdill catalog.
Cogsdill
TOOL PRODUCTS, INC.
12980 W. EIGHT MILE RD., OAK PARK 37, MICH. • WESTERN BRANCH: PHONE PL 3-3321, LOS ANGELES, CAL.
Use Reader Service Card, CIRCLE 64

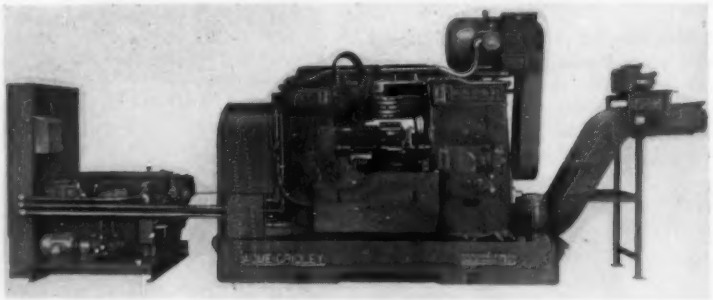
jobs, one-of-a-kind or experimental parts, maintenance and similar fabrication work. It can handle ½ to 4-inch (internal pipe size) pipe. The machine

has self-contained hydraulic operation and can be equipped with a mandrel extractor for use on small radius work.

Pines Engineering Co., Inc., 601 Walnut St., Aurora, Ill. **Circle 447**

USE READER SERVICE CARD ON PAGE 175 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Six-Spindle Shaft Turning Machine

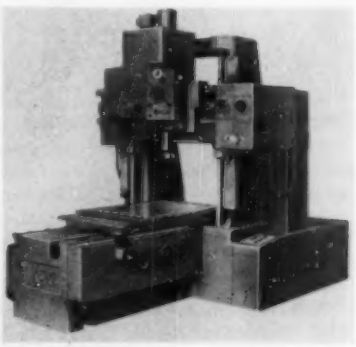


This six-spindle machine performs a variety of operations on straight and flanged shafts between centers. Its spindles can be equipped with various holding and driver devices. The machine has cam-operated lower slides and a top slide drive shaft with cam drums which allows independent operation of cross slides, turning slides or tracing slides in the fifth and sixth positions. An intermediate cross slide for forming, grooving and facing is available.

National Acme Co., 170 E. 131st St., Cleveland 8, Ohio. **Circle 448**

Jig Boring and Milling Machine

The Hydroptic 6A optical jig boring and milling machine has hydroelectric type clamping and unclamping of the worktable and a spindle-head saddle. It has a guaranteed accuracy of 0.000150 inch for individual or cumulative displacement and 0.000075 inch for any other position. The capacity of the hydraulic tank is 10.8 gal and the coolant tank, 18.6 gal. The large-capacity tanks

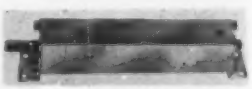


minimize excessive heating that can affect accuracy.

American Sip Corp., 100 E. 42nd St., New York 17, N. Y. **Circle 449**

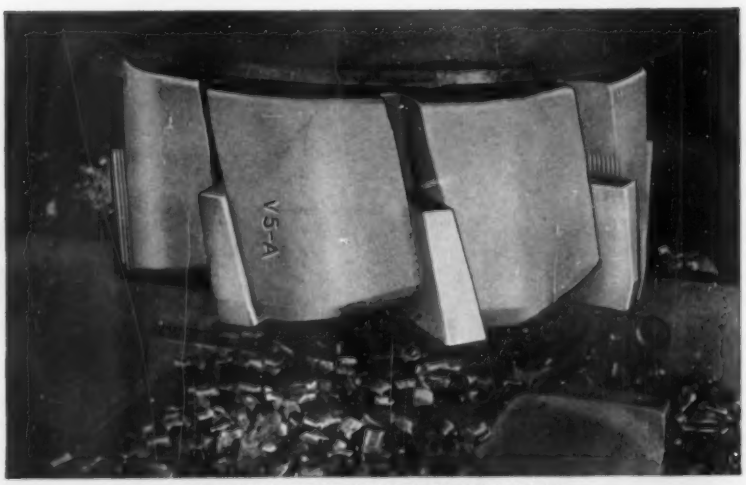
Air and Hydraulic Cylinders

Designed with a square barrel, Nopak air and hydraulic cylinders can be mounted in many ways. The head and barrel, both aluminum, are bolted directly, eliminating tie rods. A rod wiper



is built into each bore. The cylinders are offered in ¾, 1, 1½, 2 and 3 inch diam. Interchangeable mounting attachments are available.

Galland-Henning Mfg. Co., 2753 S. 31st St., Milwaukee 46, Wis. **Circle 450**



O K END MILL WITH V5A SUPER HIGH SPEED STEEL BLADES

carbide—not for every job...

The low transverse rupture strength of carbide creates problems, especially on jobs involving intermittent milling. You will need sound tool geometry, firmness for machine, fixture and workpiece. We recommend blades of V5A super high speed steel. Write for data sheets. THE O K TOOL COMPANY, INC., 300 Elm Street, Milford, New Hampshire.

OK modern milling cutters for modern milling machines

Use Reader Service Card, CIRCLE 65

Shear-Speed Shapers

Twin-column construction with integral crosshead at top permits chip removal through the rear of these Series 3000 Shear-Speed gear shapers. Model 3053 is designed for gears from 3 to 5 inches and 3073, for gears from 5 to 7

inches. Multiple single-point tools feed toward the center while the work reciprocates up and down to produce all teeth or forms on the contour of the work simultaneously.

Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich. **Circle 451**

Thickness Tester

Thicknesses of organic and nonmagnetic metal coatings on iron and steel can be tested with the accuracy of the microscopic method with the Type ES Permascope. A portable unit measuring 5¼ x 8¾ x 5 inches, it has a two-pole probe which works on the principle of a magnetic amplifier. To

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

measure the thickness of a coating, the probe is applied to the probe with the lines of force largely contained within the base metal. The thickness is indicated on one of the direct reading scales of the instrument. One model has two scales with ranges of 0 to 0.001 inch and 0.0008 to 0.0010 inch; another model has a third scale with a range of 0.008 to 0.100 inch. Hardened beryllium copper foils are furnished for calibrating the instrument.

Twin City Testing Corp., 533 S. Niagara St., Tonawanda, N. Y. **Circle 452**

Small Parts Comparator

Two instruments—an optical bench comparator and a toolmaker's microscope—are combined in one instrument for gaging small parts. The image produced on the comparator screen is correct—not inverted or reverted. Thus, the sample part and its magnified image are both viewed in the same position. This feature suits the instrument for direct assembly or adjustment of components. The focal length of the lenses used is sufficiently long so that there is ample room under the objective lens for adjusting parts without removing them from the 6¾ x 4-inch work table.

Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y. **Circle 453**

Vibration Finisher

Designed to deburr, descale and finish inside surface and hard-to-get-at areas regardless of size openings, the

Mrs. Florence Smith, operator of the Federal Products Corporation, achieves ultra-precise results with the No. 3 Moore Jig Grinder.

Woman operator at Federal Products maintains 50 millionths accuracy with No. 3 Moore Jig Grinder

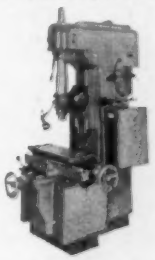
Moore Special Tool Company numbers among its long-time customers the Federal Products Corporation of Providence, Rhode Island—a leading manufacturer of dial indicating, air, electric or electronic gages—special equipment used for measuring, inspecting, sorting or automatic gaging.

The type of work produced by Federal Products calls for highly skilled personnel, not the least talented of which is a woman jig grinder operator, Mrs. Florence Smith.

Mrs. Smith has a *natural* mechanical ability. She is Federal-trained, starting in their plant during World War II. Most of her work is producing masters for precision gages with small holes and slots. Her work is extremely accurate—and she keeps complete records of work performance. She is able to maintain accuracy to within 50 millionths...using the No. 3 Moore Jig Grinder.

Moore machines have been dependable performers in Federal Products Corporation's precision grinding room for a number of years. The company also uses other Moore equipment, such as the Moore Precision Rotary Table and Moore accessories...all of which help Federal meet their customers strictest requirements.

Write today for literature describing all the advantages of the No. 3 Moore Jig Borers and Jig Grinders.



Partner in Precision: No. 3 Moore Jig Borer

This new Moore Jig Borer is unequalled for the speed and accuracy with which it bores, drills, reams and spots holes in dies, jigs and production parts. It breaks the "tenth barrier." It offers more precise positioning tolerances...improved drive ...wider speed range, 60 to 2250 RPM...larger table working surface, 11 x 24".

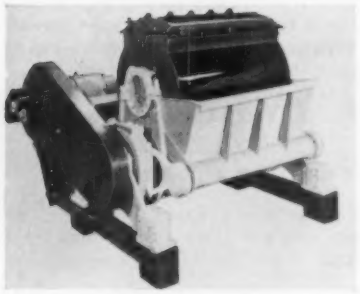
MOORE SPECIAL TOOL COMPANY, INC.
732 Union Avenue, Bridgeport 7, Conn.

HOLES, CONTOURS AND SURFACES. Tells how to produce tools and dies the modern way. 424 pages, 495 illustrations. $5 in U.S.A. $6 elsewhere.

ADD MOORE TOOLS TO YOUR TOOLROOM

JIG BORERS • JIG GRINDERS • PANTOGRAPH WHEEL DRESSERS • PRECISION ROTARY TABLES • HOLE LOCATION ACCESSORIES

Use Reader Service Card, CIRCLE 67

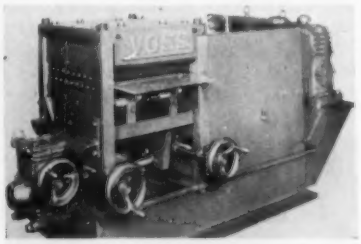


Selectro Vibro-Finisher can handle virtually every size and shape part. Its interchangeable drums are available in several sizes. Multiple-section drums are also available for finishing lots of different parts simultaneously. The vibrating mechanism is positive eccentric with adjustable stroke.

Productive Equipment Corp., 2926 W. Lake St., Chicago 12, Ill. **Circle 454**

Parts Flattener

Compact enough to sit on a desk top, the parts flattener shown straightens stamped parts rapidly and automatically. Finished dimensions within 0.002 to 0.003 inch of perfect flatness can be



achieved and parts can be fed into the machine by hand or automatically. The machine has a series of work rolls supported by multiple back-up bearings.

Voss Engineering Co., 7301 Penn Ave., Pittsburgh 8, Pa. **Circle 455**

Ejector Punch

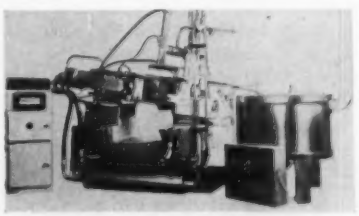
Disassembling punches or removing stripper plates is eliminated with this Pull-Pin ejector punch. The ejector pin

is removed from the punch with pliers, sharpened and pushed back in. It is available in all point shapes and head and ring types and ranges from $\frac{3}{16}$ to 1-inch diam.

Ring Punch & Die Div., Producto Machine Co., Jamestown, N. Y. **Circle 456**

Zinc Die Casting Machine

One feature of the Ram fully automatic zinc die casting machine is its "die saver" system. It detects unejected castings and foreign matter between



the dies as they lock, retracts the die and stops the cycle. Recycling begins after a brush device clears the obstruction.

The machine has die temperature control, die cleaning and lubricating mechanism, platen speed control and an automatic ladling preheat furnace. The tie bars permit a 60-ton lock. Average shots per hour with this machine is 1500.

DCMT Sales Corp., Port Washington, N. Y. **Circle 457**

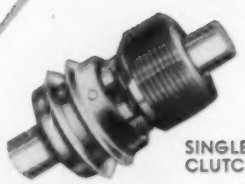
DYNAMIC POWER CONTROL *by ROCKFORD*

Pullmore Multiple-Disc Clutches

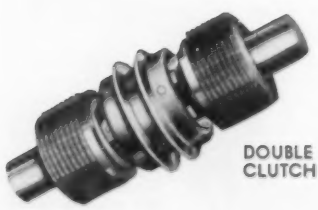
Positive, full-motion driving power with cushioned starts and controllability . . . this is Dynamic Power Control. Rockford Pullmore Clutches transmit smooth and instantaneous power in thousands of machine tools, metalworking machines and materials handling operations.

Pullmore Clutches are compact and powerful. They fit severe space limitations. The smallest model is 1¾" diameter x 2.3" long. The wide range of sizes handles torque loads from 126 to 11,000 inch pounds.

Single and double clutches are available for oil or dry operation. The versatile double clutches can drive forward and reverse, can obtain high and low speeds, or can be used as clutch and brake combinations. Rockford manufactures many industrial and automotive power controls. *Write today for illustrated brochure.*



SINGLE CLUTCH



DOUBLE CLUTCH

ROCKFORD CLUTCHES

ROCKFORD CLUTCH DIVISION BORG-WARNER

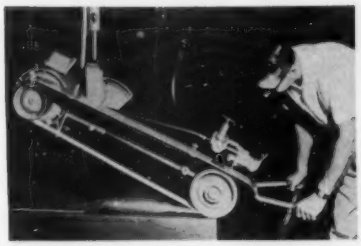
1329 EIGHTEENTH AVENUE
ROCKFORD, ILLINOIS

Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

Use Reader Service Card, CIRCLE 68

Belt Grinder

Powered with a 3 or 5-hp motor, this medium-duty grinder has a 90-inch abrasive belt with an 8-inch contact wheel. The grinder can be adapted for use as a floor-stand unit, swing-frame

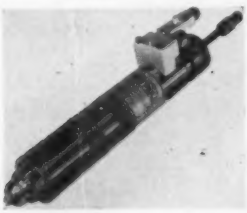


grinder or lathe-mounted cylinder, or polisher. The unit has positive air tensioning of the belt.

Grinding & Polishing Machinery Corp., 2530 Winthrop Ave., Indianapolis 5, Ind. **Circle 458**

Air Feed Drill

The Aircheck Airfeedrill is designed for production drilling of a number of holes in any material at any angle. Its features include automatic return, adjustable feed rate, adjustment for length of stroke and depth of cut and remote



control. The model is equipped with a micrometer marked thimble and graduated stop screw for setting the forward stroke in any position.

Gardner-Denver Co., Quincy, Ill. **Circle 459**

Building-Block Feed Tables

Designed for use in special machines, these feed tables and slides range in size from nine inches to two feet with longitudinal travel to 15 feet. Incorporating scraped, dovetail ways, the tables can also be used for positioning or feeding workpieces and machining units. Models are available with electric, hydraulic and pneumatic power as well as manual feeds.

Master Mfg. Co., Inc. Hutchinson, Ka. **Circle 460**

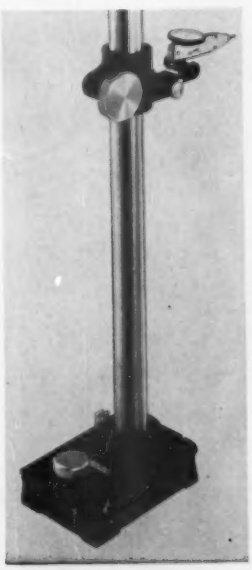
D-C Arc Welders

Idealarc R3M series three-phase rectifier d-c arc welders can be used for production, structural and maintenance welding. They incorporate silicon rectifiers to produce d-c outputs ranging from 300 to 650 amps. The front panel contains the current control for continuous adjustment of full range output without making intermediate range changes, and electrode and ground cable mounting studs which are equipped with strain lugs to prevent damage from impact or cable tugging. Standard equipment includes a polarity switch for reversing current flow without changing cable connections, a high-volume air-cooling system and a lifting bale. Thermal damage from overload, lack of ventilation, or single phasing is prevented by a pushbutton magnetic line contact which is wired to thermostats.

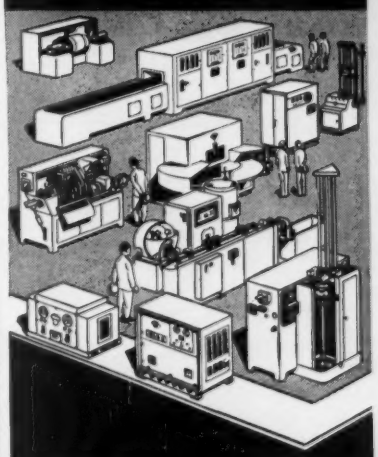
Lincoln Electric Co., Cleveland 17, Ohio. **Circle 461**

Height Stand

Model 2300 height stand permits measurements at heights up to 18 inches and can be used with electronic gage heads as well as dial indicators. Its contoured base measures 3 x 4⅜ inches, has a three-point support to eliminate any chance of rocking, and is designed so that heat transferred from the hand in no way affects the column support or its adjustment. Wide-range fine adjust-



for HARDENING • BRAZING
SOLDERING • FORGING • ANNEALING
MELTING • SINTERING • WELDING
REFINING • SHRINK FITTING
CRYSTAL GROWING



THER-MONIC

Manufactures the most complete range of

INDUCTION HEATING EQUIPMENT

ELECTRONIC • LOW FREQUENCY
MOTOR GENERATOR

THER-MONIC features

• Over 20 years of concentrated experience.

• Over 5,000 installations.

• Over 15,000 heating applications resolved in our customer service laboratories.

• This outstanding experience and know-how qualify us to prescribe the techniques and equipment best suited for your requirement.

Contact our factory or your local IHC representative.

Write for New 56-page catalog of exclusive features, facts and specs.

INDUCTION HEATING CORP.
181 WYTHE AVE., BROOKLYN 11, N.Y.

Use Reader Service Card, CIRCLE 70

we make quality tools • jigs • fixtures special machines machine components for every industrial application quickly economically

Serving all industries anywhere in the U. S. A. since 1906. A big plant filled with precision production equipment enables us to handle any size job. Write for FREE brochure listing all facilities and capacities.
phone AX. 9-2151

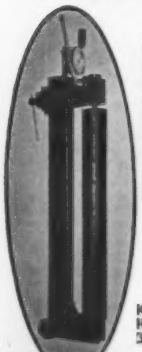
COLUMBUS DIE-TOOL & MACHINE CO.
P. O. BOX 750 • COLUMBUS, OHIO
Use Reader Service Card, CIRCLE 71

MAKE ALL BRINELL HARDNESS TESTS WITH **The KING PORTABLE TESTER**

King Test Head with Chain Adapter

King Test Head in 13½" base with King Brinell Scope

ONE TEST HEAD FITS MANY INEXPENSIVE ADAPTERS



King Test Head in 30" base

King Bore Brinell with small test head for pipes, cylinders, etc.

The KING PORTABLE HARDNESS TESTER

- To test any size, shape or thickness of metal.
- Makes guaranteed accurate on-the-spot tests — anywhere!
- Gap 10" — 13½" — 30". Throat 4" — 6¾" or larger with chain adapter.
- Loads from 62½ Kg. to full 3000 Kg. 5mm or 10mm steel or carbide ball.
- Will make tests in places no other tester can reach—including cylinder bores.

Write for literature and prices to Dept. TE-12-60

KING TESTER CORPORATION 440 N. 13th St., Philo. 23, Pa.
Known the world over for accuracy and dependability

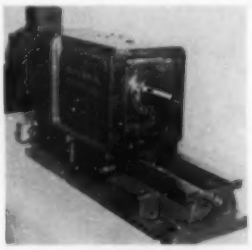
Use Reader Service Card, CIRCLE 72

ment up to 0.030 inch is located on the base and a split clamp with large knob secures the arm without need for auxiliary locking devices. The $\frac{7}{32}$-inch-diam mounting post takes a standard universal clamp and is removable for substitution of scribe marker or other transfer devices.

Federal Products Corp., Providence 1, R. I. **Circle 462**

Drill Unit

The Pneumech drill unit can be readily adapted to single or multiple spindle heads, reaming, counterboring and allied operations. It has a maximum stroke of 10 inches and combines air for feed and rapid traverse with me-



chanical restrictive forces. Feed variations from 0.0016 to 0.015 inch and speeds from 287 to 4600 rpm are possible. The unit measures 10 x 37¾ x 16½ inches and has a multiple spindle head mounting area of 10½ x 10 inches.

Hoefer Mfg. Co., Freeport, Ill. **Circle 463**

Spot-Welding Tip Holder

Designed for welding in confined areas, the Tuffaloy paddle-type spot-welding tip holder does not require the use of tee connectors. It has a 4-inch

offset. Shank diameters are ¾, ⅞, 1 and 1¼ inches.

Air Reduction Sales Co., 150 E. 42nd St., New York. **Circle 464**

USE READER SERVICE CARD ON PAGE 117 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Use Reader Service Card, CIRCLE 73

"...and safe at 150% of specified maximum speed..."

Every Peninsular wheel must pass this test—must prove before delivery to you that it can safely take half again as high a speed as the maximum safe speed recommended.

It is one of a series of grueling tests developed by Peninsular to make sure that its wheels—vitrified or resinoid—are the safest and highest performance wheels you can find anywhere.

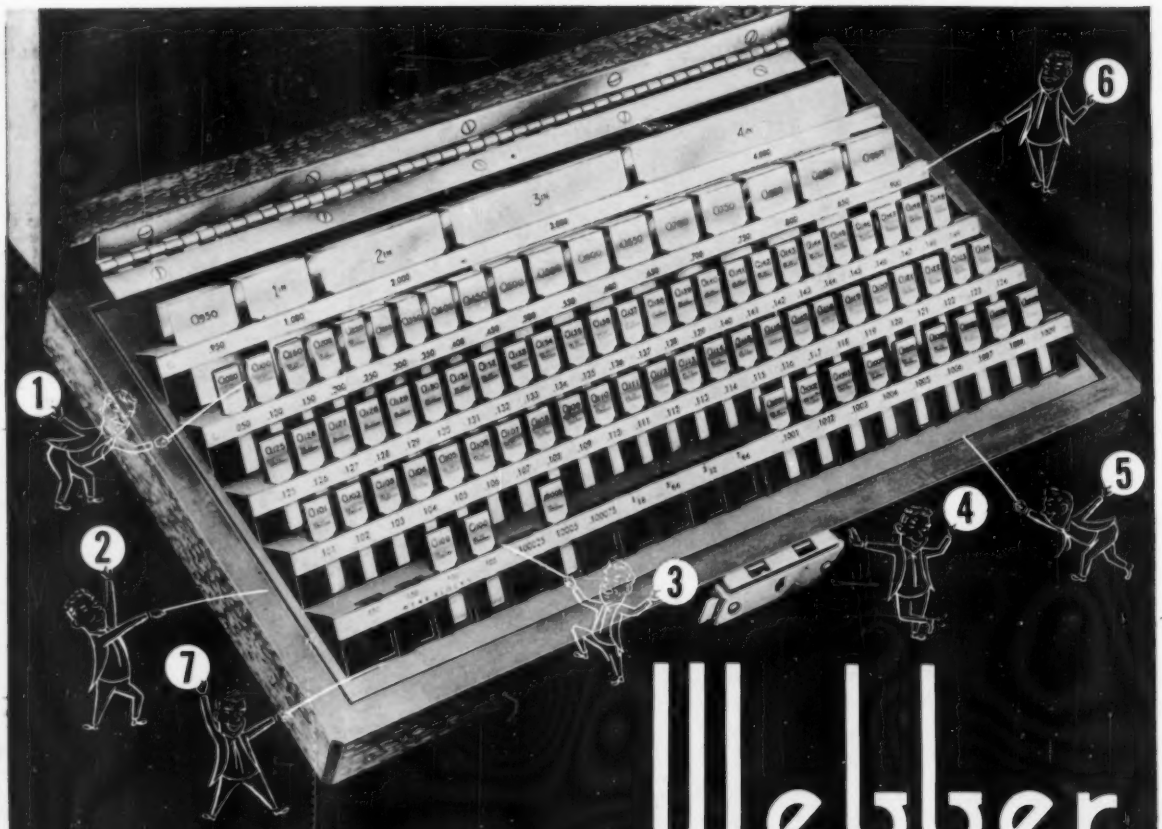
Our 1960-1961 catalog is now off the press. Ask for your copy today.

PENINSULAR

GRINDING WHEELS

District Representatives and Distributors in All Principal Cities

PENINSULAR GRINDING WHEEL COMPANY • 729 MELDRUM AVENUE • DETROIT 7, MICHIGAN



Webber

"Inspection" Quality Gage Blocks at "Working" Block Prices

1. "A +" Accuracy; + .000004", − .000002"
2. Complete 84 Block set.
3. Two .100" Croblox (Chromium Carbide) "wear" blocks included with every set.
4. Beautiful rugged Melamine case — frosted walnut grain finish. Piano hinge. Lock and key.
5. Bakelite interior, easy to clean — durable.
6. Easy to read identification strips for instant selection of blocks desired.
7. Extra cavities provided for future additions.

Complete rectangular steel 84 piece set

$287.50

New, highly efficient production equipment, designed and built by Webber "know how" and available *only* to Webber, makes possible volume production with resultant lower prices on these famous "inspection quality" gage blocks. They actually exceed the accuracies specified by the U. S. Bureau of Standards for grade "A" blocks.

Webber GAGE COMPANY 12908 Triskett Rd. Cleveland 11, Ohio

CROBLOX® GAGE BLOCKS (made of Solid Sintered Chromium Carbide) pioneered by and produced exclusively in the Webber Laboratory

who's meeting and where

Dec. 5-7. ELECTRONIC INDUSTRIES ASSOCIATION. Third conference on maintainability of electronic equipment. Sponsored (with the Department of Defense) under the chairmanship of E. B. Harwood of the Office of the Secretary of Defense. Hilton Hotel, San Antonio, Texas.

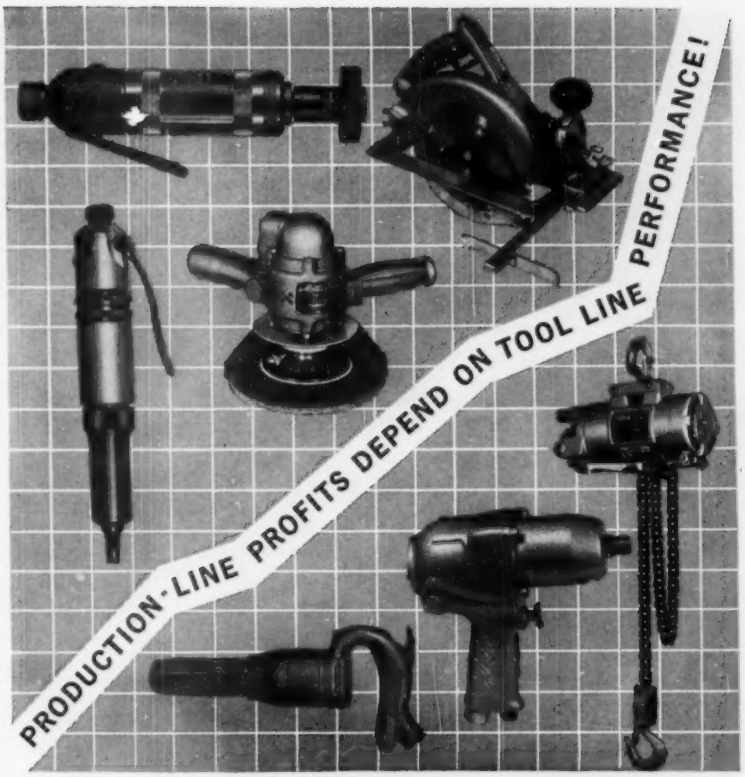
Dec. 5-8. AMERICAN ROCKET SOCIETY. Fifteenth annual meeting and astronautical exposition. Program chairman is John Sloop. Shoreham Hotel, Washington, D. C.

Dec. 6-7. UNIVERSITY OF WISCONSIN ENGINEERING INSTITUTE on inspection organization. Speakers from industry will present case histories of the organization and operation of successful inspection departments and discuss use of statistical analysis in quality control. Extension Center, Langdon and Lake Sts., Madison, Wis.

Dec. 7-8. AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS. Seminar entitled "Metal Cutting Today." Latest improvements, techniques and ideas on machinability, hot machining, finishing techniques, tool geometry, tool materials, broaching, milling, grinding, drilling and cutting fluids are to be presented. Dinkler Plaza Hotel, Atlanta, Ga.

Dec. 12-15. INDUSTRIAL BUILDING EXPOSITION & CONGRESS. Exhibits valued at more than $2,000,000 from 115 companies will be displayed. Sixty-one speakers, representing virtually every type of company presently engaged in plant expansion or modernization, will explain how their own companies tackle the problem of adding to their facilities. New York Coliseum, N. Y.

Dec. 13-15. EASTERN JOINT COMPUTER CONFERENCE. Sponsored by the National Computer Committee, which consists of representatives of the Institute of Radio Engineers, the American Institute of Electrical Engineers and the Association for Computing Machinery. Chairman of the conference is Nathaniel Rochester, International Business Machines Corp. Hotel New Yorker and Manhattan Center, New York City, N. Y.



Standardize with

MASTER POWER AIR TOOLS

Compared to other capital goods equipment, portable air tools are a minor production-line expenditure . . . yet, if they loaf on your job they can cost you considerably in lost profits. The outstanding performance of Master Power Air Tools makes the difference. Master Power's premium power in lighter weight tools means less operator fatigue, higher operator efficiency. More power-per-ratio-of-air and more powerful stroke for the same size tool means increased tool efficiency. Important, too, is hard-chromed finish wherever two hard parts work against each other. Result: up to three times normal wear. Saves you considerably on repair bills . . . saves us on extra service calls. And most Master Power Tools have interchangeable parts for extra savings in inventory, less down-time in the plant.

Consult our *Technical Service Dept.* for expert evaluation and design of your plant air tool requirements. No obligation. Simply use coupon below or call us.

MP **Master Power**

Leading distributors everywhere sell

LOOK UNDER TOOLS—PNEUMATIC

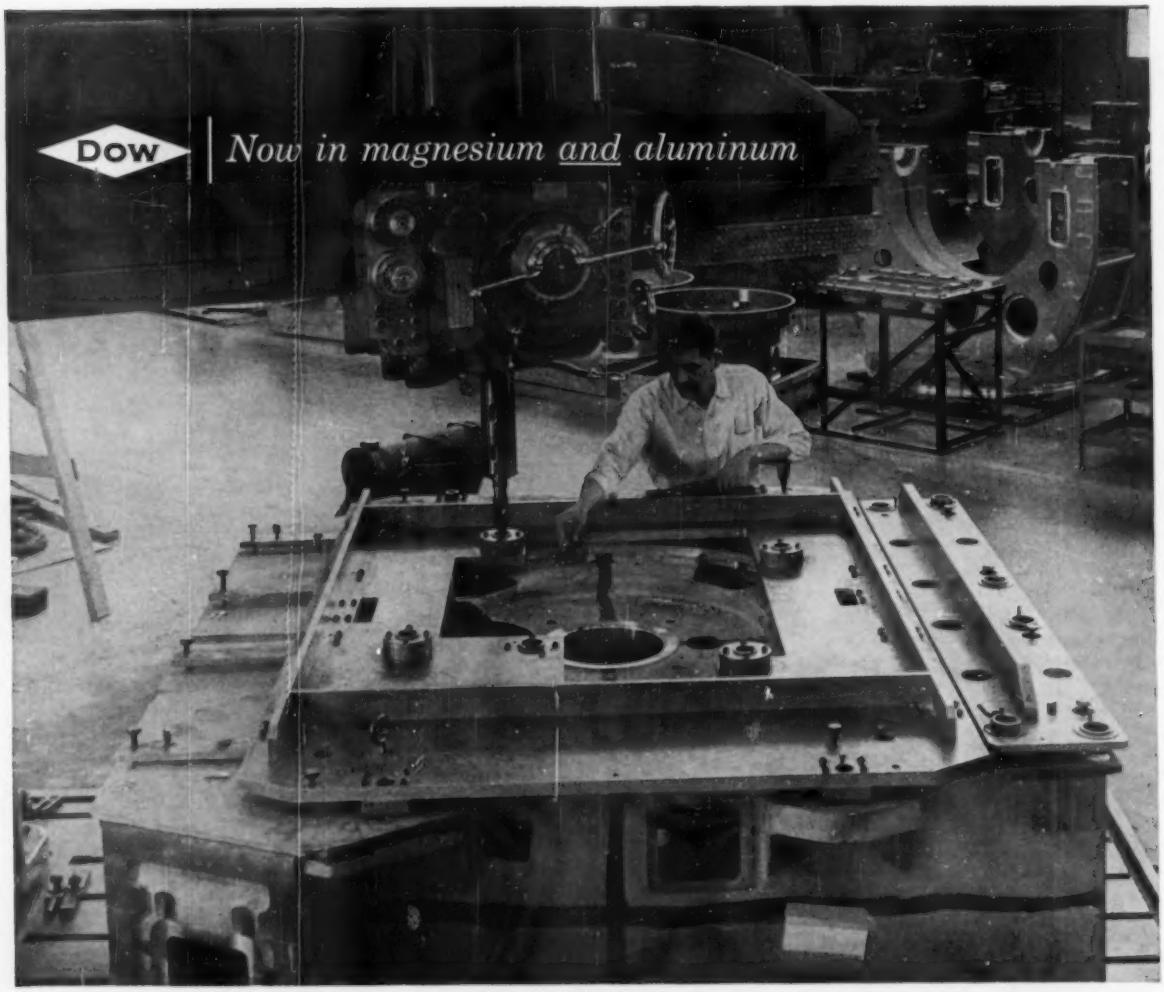
Master Power Corporation, Dept. A-120, Solon, Ohio
Gentlemen: Please send information immediately on the items checked below:

☐ Impact Wrenches ☐ Percussion Tools
☐ Threaded Fastening Tools ☐ Abrasive Tools
☐ Air Hoists ☐ Complete Air Tool Study

Name.....Title.....
Company.....
Street.....City.....Zone.....State.....

Master Power Corporation • Solon, Ohio, A **Black & Decker** Subsidiary

Use Reader Service Card, CIRCLE 75



TOTEABLE MAGNESIUM HELPS TOOL HUGE NIKE ANTENNA

"We're using more and more magnesium tooling plate in our shop because it's lightweight, easy to machine and has a superior finish," says the Director of Engineering of Steel Products Engineering Company Division of Kelsey-Hayes.

Light Weight. "We use magnesium tooling plate to make jigs and fixtures of various sizes up to seven feet square in our work on the huge Nike-Hercules antenna," he said. "The largest magnesium tools can be transported with a small lift truck, leaving our overhead crane free for other duties. Many of the magnesium tools can be handled easily by one or two men."

Machinability. "The excellent machinability of magnesium is very important since many operations must be performed to get the two sides of our jigs and fixtures parallel to .001."

Dimensional Stability. "Magnesium's dimensional stability allows us to hit milling and drilling tolerances on the finished antenna parts of .0002 to .0005."

NEW Magnesium Tooling Plate Manual covers shop working characteristics, properties, design. Contact the Dow sales office near you or write to THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1030FJ12.

DOW **THE DOW METAL PRODUCTS COMPANY**

Division of The Dow Chemical Company

George E. Barker has been named vice president and director of research at the Van Straaten Chemical Co., Chicago. He has been director of the metal laboratories of the Quaker Chemical Products Corp. and has headed group research at Atlas Powder Co. He has also been associated with the Mellon Institute of Industrial Research and the Allied Chemical and Dye Corp.

Dale M. Nevitt, former manufacturing manager, has been appointed vice-president of manufacturing of Western Design Div., U. S. Industries, Inc., Goleta, Calif. He has been with Western Design for three years. Other positions in his background have been with the National Aircraft Corp., Schwein Engineering Co., Vector Electronic Co. and Western Electric Co.

Men at Work

IRVINE F. WILLIAMSON has been appointed superintendent of Norton Co.'s Santa Clara, Calif., plant. He has served as an industrial engineer, assistant foreman of the packing and shipping department, assistant foreman of the kiln department and supervisor of the industrial engineering department since joining the company in 1954.

Richard D. Robertson, vice president in charge of manufacturing, Norma-Hoffmann Bearings Corp., has announced that WILLIAM B. CLARK has been named manager of manufacturing engineering; FRANK H. RAE, chief process engineer; and DAVID ALBERT, superintendent of inspection and quality control. Clark, previously superintendent of inspection and quality control, will be responsible for supervision of all manufacturing engineering activities covering the entire line of precision ball, roller and thrust bearings at the Stamford, Conn., plants. Rae, who will be responsible for development of new manufacturing techniques, has served in various research and engineering posts. Albert previously served as chief customer representative.

Cogsdill Tool Products, Inc., manufacturer of special hole deburring and hole finishing tools, has announced the election of GENE A. WHITE as president. He succeeds FRANK A. COGSDILL, who has been named vice-chairman of the board of directors.

ROGER W. TUTHILL, appointed manager of engineering for Air Reduction Sales Co.'s special products department, will supervise the design and construction of custom-made equipment involving uses for gases and the cutting and joining of metals. He was formerly assistant manager of the equipment engineering and development department. He has done considerable work on gas shielded methods of welding.

Consolidation of the West Allis centrifugal pump department and the compressor department under the management of E. F. GREIWE has been announced by Allis-Chalmers Mfg. Co. Greiwe, who was previously manager of the Norwood (Ohio) Works centrifugal pump department, is succeeded by R. J. DINEEN. Other new appointments at the West Allis Works are C. F. CODRINGTON, manager of sales; H. L. ROSS, manager of engineering;

Kurt W. Leibfritz has been appointed chief engineer of the air valve department of the Valve and Crown Div. of the Hannifin Co. He has had broad experience in laboratory experimentation and design of compressed air components. Since joining Hannifin in 1957, he has served as design engineer.

John S. Randall has been elected to succeed Ralph W. Burk as executive vice president of Kearney & Trecker Corp., Milwaukee, Wis. He was formerly vice president of the A. O. Smith Corp. and has served in a similar capacity with the Superior Separator Co. and the Minneapolis-Honeywell Regulator Co.

Henry C. Jones, executive vice president and director of operations, has been appointed president and a director of Electrada Corp., Beverly Hills, Calif. He will be the chief executive officer of the corporation and its divisions. Jones previously served 18 years in executive positions at Convair.

James P. Fairbairn has been named chief engineer of mobile hydraulic cylinders by H. H. Adams, vice president and manager of the Power Cylinder Div. of the Hannifin Co. Fairbairn was formerly plant engineer and, prior to joining Hannifin, served as plant engineer for Revere Copper and Brass, Inc.

modern MACHINES *demand*

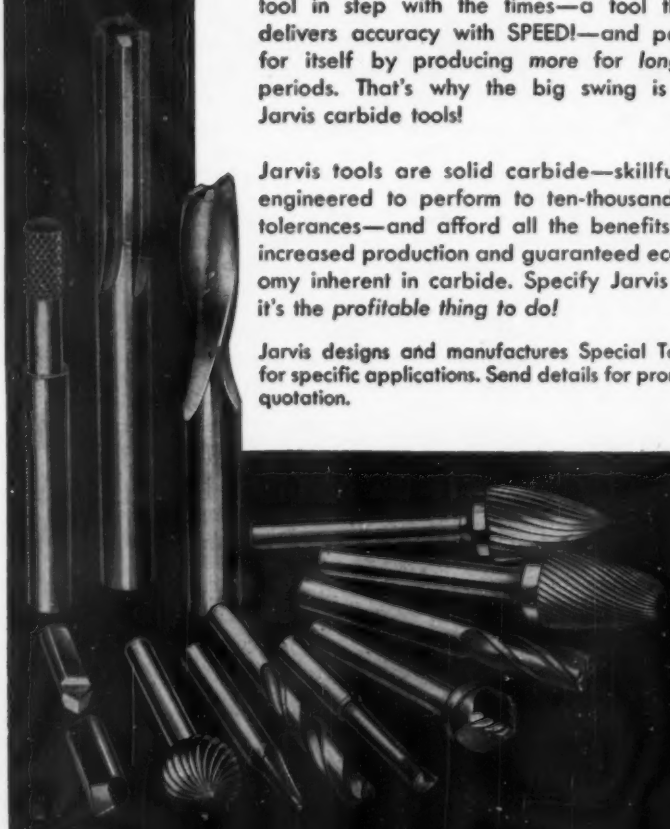
MODERN *solid carbide* **TOOLING!**

Jarvis **SOLID CARBIDE GIVES MAXIMUM EFFICIENCY AND ECONOMY!**

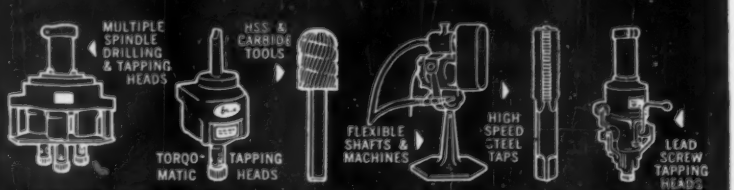
Forward-thinking management demands a tool in step with the times—a tool that delivers accuracy with SPEED!—and pays for itself by producing *more* for *longer* periods. That's why the big swing is to Jarvis carbide tools!

Jarvis tools are solid carbide—skillfully engineered to perform to ten-thousandths tolerances—and afford all the benefits of increased production and guaranteed economy inherent in carbide. Specify Jarvis... it's the *profitable thing to do!*

Jarvis designs and manufactures Special Tools for specific applications. Send details for prompt quotation.



NOTE: SOME AREAS ARE OPEN FOR REPRESENTATIVES OF OUR SOLID CARBIDE TOOLS


MULTIPLE SPINDLE DRILLING & TAPPING HEADS
HSS & CARBIDE TOOLS
TORQO-MATIC TAPPING HEADS
FLEXIBLE SHAFTS & MACHINES
HIGH SPEED STEEL TAPS
LEAD SCREW TAPPING HEADS

JARVIS CORPORATION • MIDDLETOWN, CONNECTICUT

Use Reader Service Card, CIRCLE 77

Men at Work

C. L. BRISLEY, chief industrial engineer; and L. M. DINGS, chief production engineer. JAMES E. HEMPHILL and GEORGE R. THOMAS have been assigned posts as assistant engineers with in the engineering laboratory and the tool engineering department and JOHN C. ECKELS, as assistant engineer in the plant engineering department at the Boston, Mass., plant.

Edward P. Sandbach has been appointed manager of manufacturing of the Mackintosh-Hemphill Div. of E. W. Bliss Co. Succeeding C. E. Peterson, who has been named division manager, Sandbach will be in charge of manufacturing operations at the Pittsburgh and Midland, Pa., plants. He was formerly chief metallurgist.

William P. Panny has been appointed as vice-president of Pioneer Engineering & Manufacturing Co. Joining Pioneer after nine years with Chrysler Corp., Panny most recently assistant chief engineer on light and medium-duty trucks. In 1958, he received "The Outstanding Young Engineer of the Year Award" from the Engineering Society of Detroit.

LAWRENCE V. WHISTLER, JR., has been elected president of S. B. Whistler & Sons Co., Buffalo, N. Y. He has been vice president of the firm for the past 10 years. He succeeds LAWRENCE V. WHISTLER, SR., who is now chairman of the board.

Oscar Ahlers is the successor of C. Thorpe Thompson as vice president and general manager of the Sheffield Corp. Also announced was the appointment of Roy Heldenbrand as vice president of operations. Heldenbrand, who is being transferred from his position as president and general manager of a Sheffield subsidiary, the Threadwell Tap & Die Co., succeeds Louis Polk, Jr.

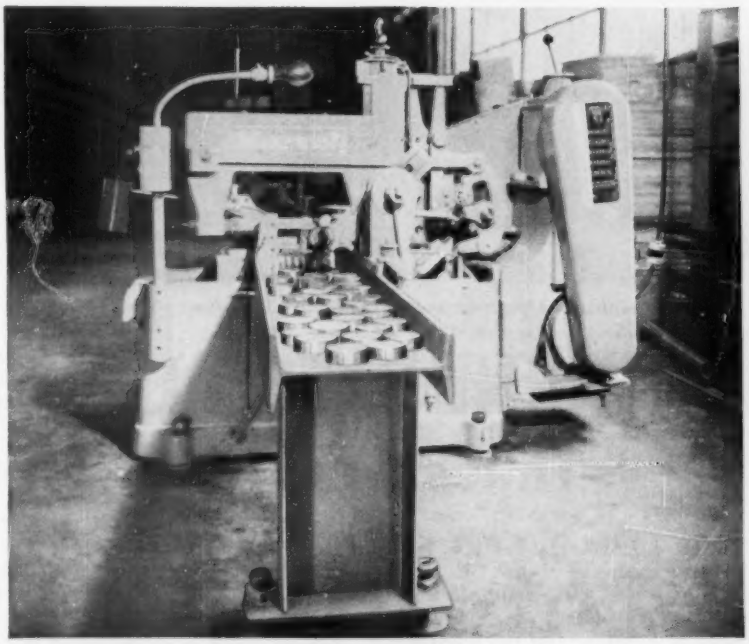
Arthur E. Hartung has been appointed by Elion Instruments, Inc., Bristol, Pa., as manager of the product engineering department. His background includes service with the RCA defense electronics plant, Teledynamics Corp., International Business Machines Corp., J. M. Lehmann Co. and the Chrysler Corp. Hartung joined the Elion staff on September 1 of this year.

CURTIS C. CARMICHAEL succeeds SHERMAN J. FITZSIMONS as president of Copper and Brass Sales, Inc., Detroit, Mich. He has been associated with the company for the past 28 years and has held the offices of secretary-treasurer and general manager. He is president of the National Assn. of Aluminum Distributors and past president of the Copper and Brass Warehouse Assn.

LEONARD STERNFIELD and RICHARD B. DOW have been added to the engineering staff of Martin Co.'s Baltimore division. Sternfield, who served previously with the National Advisory Committee for Aeronautics and the National Aeronautics and Space Administration, is chief of the flight dynamics section. Dow, principal engineer of systems criteria, has performed research for the Air Force Air Research and Development Command and with the Navy Bureau of Ordnance.

STANLEY R. BURLESON has been appointed as application engineer of the Colmonoy Div., Wall Colmonoy Corp., Detroit, Mich.

Ellison Machinery Co. has announced the appointment of CHARLES M. LETZ as vice president and general manager. Before joining Ellison as a sales engineer, Letz was district supervisor of sales engineering at Axelson Mfg. Co.



Payoff End of a Production Marvel

A cut-off saw's value is proven at the discharge end of the machine. How quickly the trough is filled with accurately cut-off pieces can mean the difference between profit and loss on many jobs.

The R. J. Sudrick Co., Des Plaines, Illinois, manufacturers of precision aircraft components had to cut-off 4600 blanks from 3¼" round, 303 Stainless Steel Bars.

They bought our MARVEL No. 6A4 High Speed Heavy Duty Automatic Bar Feed Hack Saw Machine; used MARVEL High-Speed-Edge Hack Saw Blades, and got the high production, accuracy and economy they desired.

PRODUCTION? Constant at 20 pieces per hour floor to floor

ACCURACY? Held well within the permissible tolerance of +.010 —.000

BLADE COST? Just 1½¢ per cut. Only twenty-three MARVEL blades were needed to make the 4600 cuts, and not a single blade failure due to blade breakage. MARVEL High-Speed-Edge Blades are unbreakable.

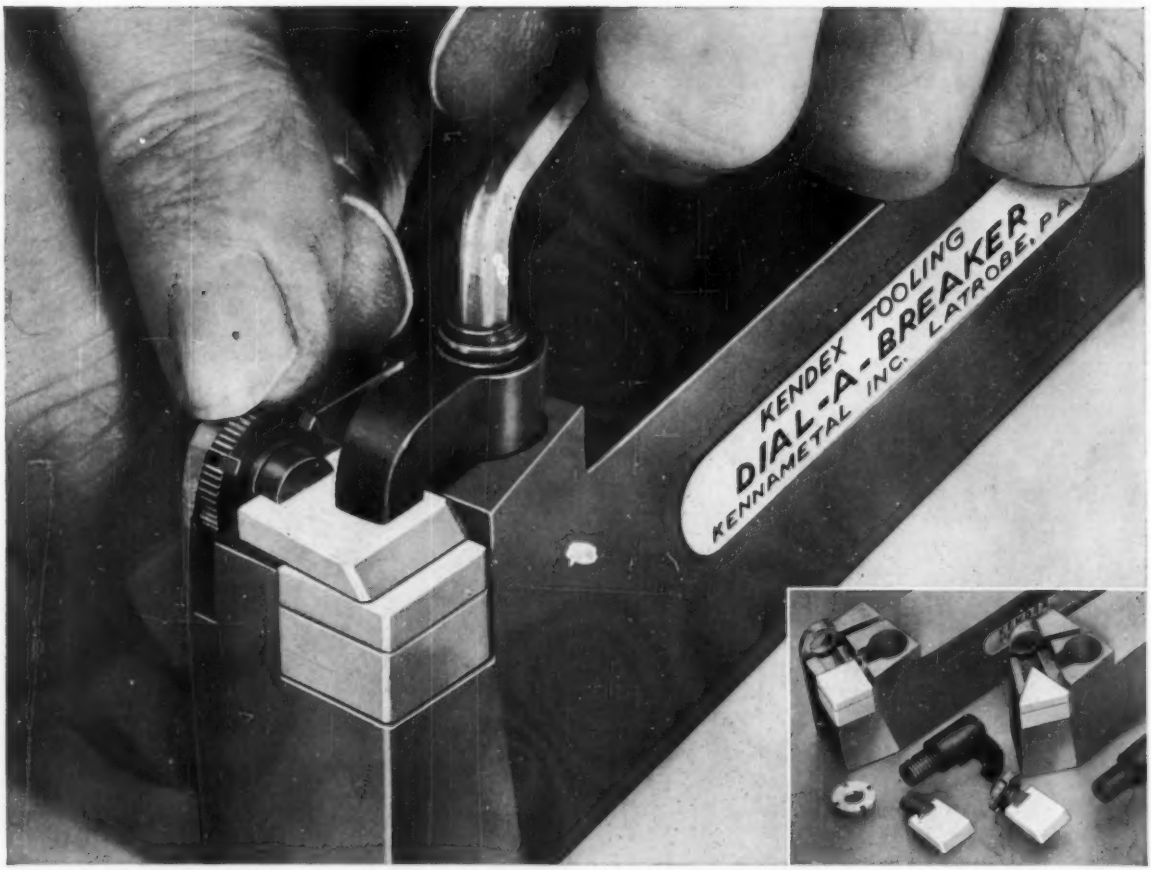
The point is this: MARVEL Metal Cutting Hack Saws equipped with MARVEL High-Speed-Edge Hack Saw Blades are an unbeatable combination for economical, accurate and safe cutting-off.

If your hack saws are not producing the economy you need to meet today's competition, try MARVEL High-Speed-Edge Blades. They will give you the competitive edge every time. Write for Catalog C-85 which has the complete story on MARVEL Hack Saws and Band Saws, Hack Saw Blades and Band Saw Blades.

ARMSTRONG-BLUM MFG. CO.
8700 W. BLOOMINGDALE AVE., CHICAGO 39, ILL.

MARVEL Metal Cutting SAWS

Use Reader Service Card, CIRCLE 78



Easy adjustment, regardless of tool position. Just release the clamp and "dial" the breaker to any position desired.

KENDEX* DIAL-A-BREAKER*

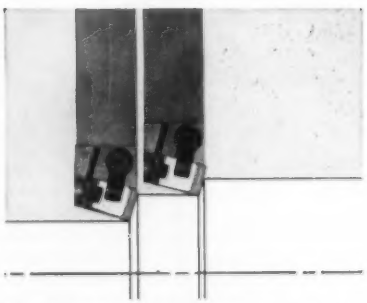
Timesaver . . . and profit maker

Chipbreakers may seem to be a trivial expense item. But final inspection of your profit on a job may prove otherwise. First, consider how much your machines and operators cost you every working minute. Then consider the fact that you are actually *losing* that much for every minute of downtime while making chipbreaker changes and adjustments to get proper chip control on every job. Add to this your daily grinding cost to maintain and modify chipbreakers. When you multiply this daily cost by the number of working days in the year . . . you may discover a serious *profit leak*.

With the Kendex Dial-A-Breaker, you can turn much wasted time into profitable production. The chipbreaker can be quickly adjusted for efficient chip control over a wide range of jobs by merely turning the dial. The chipbreaker setting is retained while changing inserts, since the chipbreaker is brazed to the adjustment screw. It can't fall out! And two sizes of chipbreakers service 70 styles and sizes of Kendex holders, eliminating the need for a different chipbreaker on every job . . . and the expense of grinding chipbreakers.

Kendex Dial-A-Breaker Holders accommodate the same solid Kennametal shims and "throw-away" inserts that are used in standard Kendex holders. Square and triangular inserts are stocked in positive and negative rake.

Get the complete story on how the Kendex Dial-A-Breaker can help you turn idle machine time into profitable production. Call your Kennametal Representative or write KENNAMETAL INC., Latrobe, Pa.



Kendex Dial-A-Breaker design permits close ganging of tools. All adjustments, chipbreaker and insert, can be made from the top of the holder.

*Trademark

33567

INDUSTRY AND KENNAMETAL
...Partners in Progress

Field Notes

A $4,400,000 program in materials science is under way at the **University of Pennsylvania** for the **Advanced Research Projects Agency** of the **Department of Defense.** Directed by John N. Hobstetter, professor of metallurgical engineering, the contract provides for studies in experimental and theoretical solid state physics, structural chemistry, inorganic chemistry and ceramics, and for the erection of a building to house the project. The building, a three-story structure with a floor area of 65,000 sq ft, will be erected on the campus and is to be occupied in the fall of 1962.

acquisitions

Optical Gaging Products, Inc., has acquired the assets of **Automated Reproductions Co.,** Detroit, Mich., developers of methods and equipment for plastics etching on Plexiglas, vinyls, butyrates and styrene. Plans are being made to transfer this operation to the Optical Gaging plant in Rochester, N. Y.

Brummer Seal Co., Chicago Heights, Ill., manufacturers of an extensive line of mechanical seals for automotive engines, water pumps and other applications, has been acquired by the **Spring Div.** of **Borg-Warner Corp.** The seal company will be known as the **Brummer Seal Div.** of **Borg-Warner Corp.** Arthur J. Welch, president and general manager of the Spring Div., will serve the division in this capacity.

Hovis Screwlock Co., Warren, Mich., manufacturers of interchangeable punches, bottom dies and compounding blanking dies, has been purchased by **Specialty Steel Products, Inc.,** Pittsburgh, Pa. Richard Koch, who has been serving as vice president, was named president of the division.

new facilities

The Data Systems Dept. of **United Aircraft Corp.'s Norden Div.** has been moved to enlarged engineering-research and manufacturing facilities at Costa Mesa, Calif. Housed in the 50,000-sq ft building, the department is engaged in the development and production of digital computing and data handling systems, including a complete line of numerical control systems for machine tools.

Armco Steel Corp., New York, has announced a $95,000,000 construction program aimed at increasing efficiency and broadening the company's product line. A part of a $341,000,000 five-year improvement plan, the new facilities will be built at the company's Ashland, Ky., and Houston, Texas, plants. At the Ashland Works, the added processing and finishing facilities will permit greater utilization of the full capacity of the plant's hot strip mill. The addition of the combination mill at the Houston Works will enable wider and heavier plates to be produced. The program is scheduled for completion in 1962.

moves

A. B. Metsger, vice president of the **Cooper Development Div., Marquardt Corp.,** has announced that the division will move to Van Nuys, Calif., site of Marquardt's Power Systems Group. The move will provide easy access to the Power Systems Group's advanced rocket engine, fuel and propellant research, high temperature materials development and experimentation and advanced manufacturing techniques.

Giddings & Lewis Machine Tool Co., 100-year-old builder of machine tools, Fond du Lac, Wis., has moved the manufacture of its Bickford line of drilling products to enlarged quarters in Kaukauna, Wis. The previous site of the division in Cincinnati, Ohio, has been purchased by the **Cincinnati Milling Machine Co.**

awards

Gray Iron Founders' Society honored four industry members for outstanding contributions to the society and industry at the 32nd annual meeting. Those cited were Charles R. Gregg, president, Gregg Iron Foundry, El Monte, Calif.; J. Edward Quest, former president, Shakopee Foundry Co., Shakopee, Minn.; J. T. Boyd, vice president and general manager, Goldens' Foundry & Machine Co., Columbus, Ga.; and Albert M. Nutter, treasurer, E. L. LeBaron Foundry Co., Brockton, Mass.

Harold W. Paxton, associate professor of metallurgical engineering, Carnegie Institute of Technology, received the **American Society for Metals** $2000 Bradley Stoughton Award for outstanding young teachers of metallurgy. A native of England, Paxton has published a number of articles in *Transactions* of the American Society for Metals, *Acta Metallurgica, Journal of Applied Physics* and *The Journal of the Iron and Steel Institute.*

association news

The National Tool & Die Manufacturers Assn. concluded its annual convention with a name change to **National Tool, Die & Precision Machining Assn.** The following officers for 1960-61 were elected: president, Harold G. Murdock, vice president, Arrowsmith Tool & Die Corp., Los Angeles, Calif.; 1st vice president, John D. Dewhurst, president, Arrow Tool Co., Inc., Wethersfield, Conn.; 2nd vice president, E. W. Barnwell, president, Apex Corp., Roseville, Mich.; treasurer, Rolf H. Berg, vice president and treasurer, Atols Tool and Mold Corp., Chicago, Ill.; and secretary, Fred D. Wright, president, Fred D. Wright Co., Nashville, Tenn.

Napoleon A. Vigeant, president of M & V Electroplating Co., Newburyport, Mass., has been named general chairman of the 1961 convention committee of the **National Association of Metal Finishers.** He will be responsible for planning and implementing a four-day meeting scheduled to be held in Boston, Mass., June 16-19, 1961.

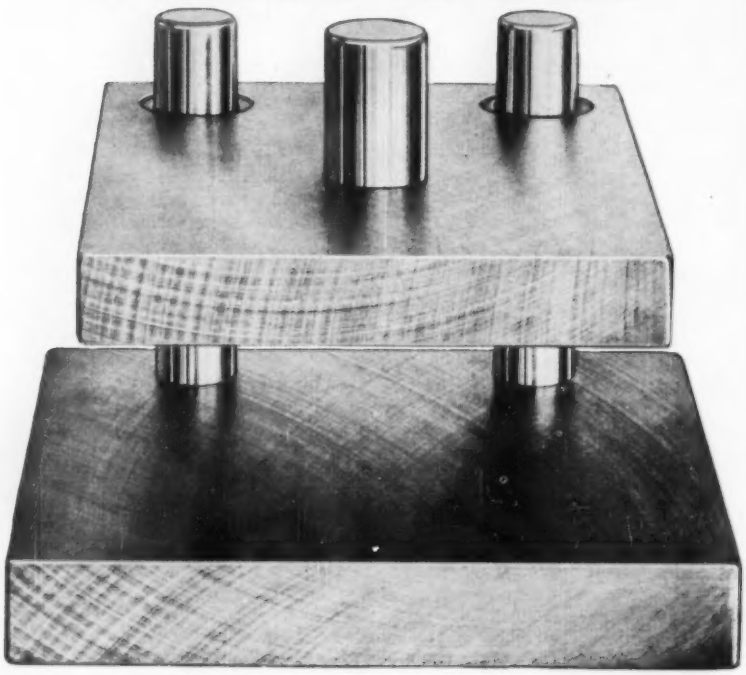
Thomas A. Marshall, Jr., has been elected executive secretary of the **American Society for Testing Materials.** Currently senior assistant secretary of the American Society of Mechanical Engineers, Marshall will head a staff which supports a society of 10,500 members and 6000 additional committee members.

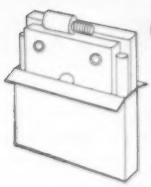
The following officers of the **Pressed Metal Institute** were elected for the coming year: president, M. A. Sherwood, Grand Haven Stamped Products Co., Grand Haven, Mich.; vice presidents, W. J. Primrose, Jr., Dickey-Grabler Co., Cleveland, Ohio, and C. W. Cederberg, Larson Tool & Stamping Co., Attleboro, Mass.; secretary-treasurer, W. Bryant Gemmill, American Stamping Co., Cleveland, Ohio; and honorary secretary-treasurer, Melvin Lorentz, HPL Mfg Co., Cleveland, Ohio.

John E. McIntyre, vice president and general manager, Sibley Machine and Foundry Corp., South Bend, Ind., has been named president of the **Gray Iron**

Top Quality — Bottom Prices

ECONOMY
STEEL DIE SETS





COMPACT, ECONOMICAL, ALL STEEL SETS

in Handy Kit Form

E ECONOMICALLY produced by volume buying and modern equipment to offer you all steel accurate die sets for low tool costs.

C CONVENIENTLY packaged for easy and safe handling.

O ORDERED with your choice of three common pin lengths—and two shank sizes—no extra charge.

N NET PRICES—1 to 9 sets. Generous discounts for quantity orders.

O ORDERS shipped directly from stock. No waiting for assembly or packaging.

M MORE die area on die holder if required, or can be used for clamping space.

Y YOUR toolmaking time is reduced by spotting die sections, and drilling or machining die holder before the pins are installed.

These Die Sets Warrant Your Investigation

WRITE for FREE catalogue to:

WHEATLEY ECONOMY DIE SETS, INC.
1627 West Fort Street • Detroit 16, Michigan
Phone: WOodward 1-2878

Use Reader Service Card, CIRCLE 80

Field Notes

Founders' Society. Other officers elected were Cecil Garland, secretary and comptroller, W. O. Larson Foundry Co., Grafton, Ohio, as vice president; J. T. Boyd, vice president and general manager, Goldens' Foundry & Machine Co., Columbus, Ga., as secretary; Paul H. Scherf, executive vice president, Alten Foundry & Machine Works, Inc., Lancaster, Ohio, as treasurer; and W. F. Seelbach, vice president, Forest City Foundries Co., Cleveland, as assistant treasurer. Donald H. Workman was reappointed as executive vice president.

Everett M. Hicks, vice president and general manager of the machine tool division of the Norton Co., was elected president of the **National Machine Tool Builders' Assn.** at its recent fall meeting. Francis J. Kearney, president of Kearney & Trecker Corp., and Wallace E. Carroll, president of the American Gage and Machine Co., will serve as 1st and 2nd vice presidents. Treasurer is Lawrence C. Gleason, president and general manager of the Gleason Works, and Grayson M. Stickell, president and general manager of the Landis Machine Co., is secretary.

new activities

Schaevitz Engineering, Pennasuken, N. J., producer of electromechanical recording, measuring, indicating and controlling devices, will begin production shortly of a complete line of motors which produce the mechanical energies its instruments control. "Unique about the new venture," said Herman Schaevitz, president, "will be our ability to perform the precalculation, design, testing and production of a prototype for delivery within a period of two weeks."

Vanadium-Alloys Steel Co. has announced the organization of a Cast-to-Shape Products Dept. in order to meet the requirements of industry for tool and special steel castings. The department, located in the main plant at Latrobe, Pa., has been manufacturing sand, shell and Shaw Process castings. Heading the department is Oliver H. Cook.

expansions

De Laval Steam Turbine Co., Trenton, N. J., has announced the establishment of two independent operating divisions, separating its larger custom-made products from its smaller standardized products. Also announced was the transfer of its Delroyd worm gear business to **De Laval-Holroyd, Inc.,** also of Trenton, an affiliate which it jointly owns with

John Holroyd and Co., Ltd., Milnrow, Lancashire, England. The machinery division will design and manufacture steam turbines, compressors, centrifugal pumps, marine gears and other large products usually made to customer specifications. The power auxiliaries division will initially include foundry products and pumps and will act as a subcontractor to the machinery division for certain components for which its manufacturing facilities are better suited.

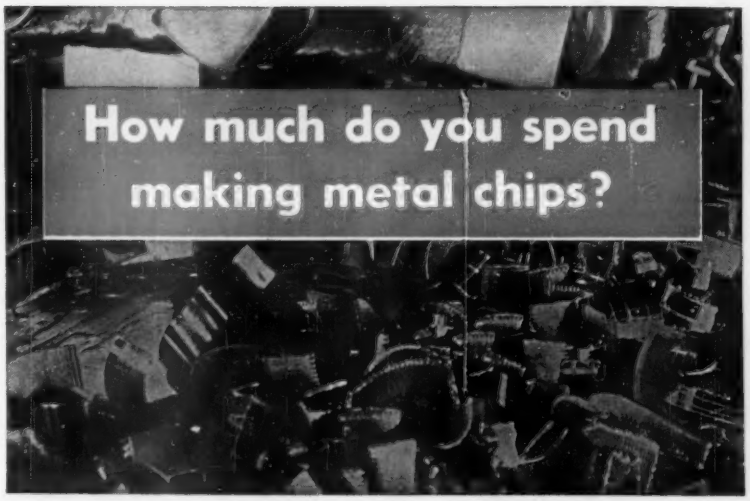
Steel construction and brick work are under way for two manufacturing plants, one in England and one in Germany, for the **Illinois Tool Works,** Chicago. The England company, **IT-S Ltd.,** produces patented plastic-rivets, grommets, rings, shelf supports and other plastic parts and administers the licensing programs of Shakeproof and Fastex products in Europe.

Pyron Co., a unit of the **Amco Div. of American Metal Climax, Inc.,** has reached agreement with **Cunningham-Limp Co.** for construction of a new, highly automated iron powder plant in Niagara Falls, N. Y. The completion of this plant in the spring of 1961 will triple the company's production capacity.

Schori Process Corp., Port Washington, N. Y., announced the establishment of a **Plasma Systems Div.** Both contract spraying of plasma coatings and research and development work on their application and evaluation are offered by this division.

Formation of a new marketing and manufacturing division to produce close tolerance cold headed and roll-formed parts on special order has been announced by A. W. Armour, president of **Huck Mfg. Co.,** 2480 Bellevue Ave., Detroit, Mich. Heading the division, designated the **Special Product Div.,** will be Arthur W. Ackerman, Jr.

Bohn Aluminum & Brass Corp., Detroit, Mich., has started a building program to expand three of its plants. The major item is an addition to the Danville, Ill., plant, which produces a complete line of heat transfer equipment for the heating, air conditioning and commercal refrigeration industries. In the foundry division, the Butler, Ind., and South Haven, Mich., plants are also being expanded. At Butler, production facilities for permanent mold castings are being enlarged by an addition to the present building and the installation of additional melting, production and laboratory equipment. At South Haven, where aluminum pistons and castings are manufactured, a new engineering building will be added.



15 MILLION TONS OF CHIPS ARE MADE EACH YEAR AT A COST EXCEEDING $10,000,000,000!

Your shop, large or small, pays its proportionate share of this *tremendous* expenditure. Having at your fingertips an authoritative reference work cataloging all available literature on metal cutting (chip producing) processes, will enable you to quickly locate information on methods and techniques being used by others all over the world.

ASTME's new METAL CUTTING BIBLIOGRAPHY compiled by The John Crerar Library in Chicago lists 18,000 references and contains 5,593 specially prepared abstracts.

If you're in metal cutting, you need this book — It could SAVE YOU MONEY!

ORDER YOUR COPY NOW!

Please send check, money order or company purchase order.

Name: _____

Company: _____

Address: _____

_____

_____

Mail to:
ASTME RESEARCH FUND • 10700 Puritan • Detroit, Mich.

Precision Parts Assure Precision Performance from O-M Cylinders!

ALL O-M CYLINDERS MEET JIC STANDARDS

With all matching parts and mounts machined to close tolerances, O-M Air and Hydraulic Cylinders eliminate misalignment friction, unnecessary wear on rod, bearings packings, also reduce maintenance, when operated singly or in sequence under automatic cycling. The length and direction of piston rod travel is accurately controlled whether the job calls for moving a machine member, holding a tool, positioning, clamping, releasing a work piece, activating an indexing table or other applications. In addition, precise cushioning against piston shock on thrust and return strokes makes for smoother, dependable operation.

O-M Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Complete line of interchangeable parts and mounts. Immediate delivery on most sizes.

If you are designing air or hydraulic cylinders into original equipment for precision control of linear motion, coupon below will bring our latest bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data. For your copies, **MAIL COUPON TODAY.**

Bulletin 101A for Internal Key Tie-Rodless type Air and Hydraulic Cylinders featured above.

Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders Hydraulic 2000 psi; 3000 psi non-shock.

Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.

Bulletin 108—Automation (Heavy Duty) Hydraulic Cylinder—for 1000 psi operation.

ORTMAN-MILLER MACHINE COMPANY
13 143rd Street, Hammond, Indiana

Send Bulletins

☐ Have representative call ☐ 101A ☐ 105A ☐ 107 ☐ 108

Name_____ Position_____

Company_____

Address_____

City_____ Zone____ State_____

Use Reader Service Card, CIRCLE 82

ENGINEERING BOOKSHELF

HANDBOOK OF PRACTICAL ELECTROPLATING—*By Thomas M. Rogers. Published by the Macmillan Co., 60 5th Ave., New York 11, N. Y. Price $8.50. 333 pages.*

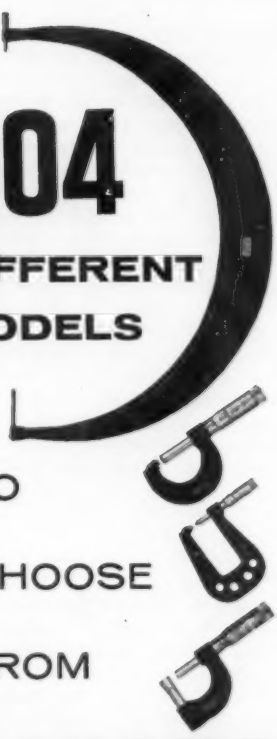
Although many excellent books have been published on electrochemistry, the actual work done in the plating shop has been treated only lightly and this handbook is intended to fill the void. Written in encyclopedic form, it is a quick and comprehensive aid to various problems in electroplating. It progresses from abrasives, acid dipping, activated carbon to zinc-base die castings, and zirconium plating. Included are the formulas for all the basic plating baths, sections on the installation and maintenance of equipment, salt-water gilding and immersion plating. Added emphasis is given to the problems of achieving various decorative colors Each type of plating is described in terms of its industrial uses, equipment, solution composition, operation, maintenance and analytical control of solution.

Whether the reader is a worker in a plating shop, a supervisor who has recently been assigned the responsibility of running a plating shop or a person technically trained in some other field, this book is designed to answer his problems.

HOW TO CHART DATA—*By Phil Carroll. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. Price $7.50. 260 pages.*

This book is a revision of Mr. Carroll's previous work, *"How To Chart Timestudy Data,"* which was published in 1950. Simplicity from complexity seems to be the author's key thought in this easily comprehended and interesting text. Methods for using charts to solve problems involving multivariables and also those problems generally believed to be solvable only through the use of operations research and computers are special features. This is shown by explaining types of data required for various problems and further show-

904 DIFFERENT MODELS TO CHOOSE FROM



SLOCOMB MICROMETERS

Whatever your micrometer requirements, chances are Slocomb has it. Slocomb micrometers range from the 1" conventional micrometer calipers to 60" Rigitube models. Airfoil, tube, screw thread and sheet metal types . . . just to mention a few of the many available specials . . . as well as the new Slocomb Snap Gage micrometer, designed to eliminate a complete line of fixed snap gages.

All Slocomb micrometers have as standard optional features your choice of terminals . . . carbide, 60° points, ½" diameter discs, ball ends or rounded anvil.

SPEEDMIKE

Another Slocomb first! Digitally read, the new Speedmike achieves the ultimate in measuring speed and accuracy. Yes . . . you can have Speedmike's "direct reading" feature on other Slocomb micrometers.

SLOCOMB

Stocked and Sold By Your Industrial Distributor

J. T. Slocomb Co.
101 Matson Hill Rd., So. Glastonbury, Connecticut

Use Reader Service Card, CIRCLE 88

ing methods of presenting this data in easy-to-analyze form.

Some of the subjects included by the author are straight-line equations, standards for curve drawing, constant-percent charts, space factors in charting and useful alignment charting. Since charts may take many forms—some better than others for specific sets of conditions—six different charts forms are dealt with and their development shown in progressive illustration. Of special interest are original charts that indicate probable profit or loss resulting from sales of four different products over a range of product mix from $120,000 minimum to $480,000 maximum.

This book aims at helping company managers make more "right" decisions by showing them how to chart variable data in a more effective and efficient manner. As such it is an invaluable tool for better management in areas of work measurement, plant scheduling and cost control.

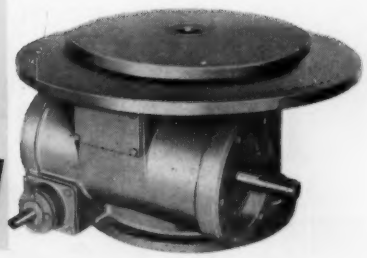
BASICS OF INDUCTION HEATING—VOLUMES *1* AND *2—By Chester A. Turbury. John F. Rider Publisher, Inc., New York, N. Y. Price $3.90 each. Volume 1, 140 pages, Volume 2, 144 pages.*

Any reader possessing a knowledge of the fundamentals of electricity will find this informative book at once useful and easy to understand, for it presents the basic principles underlying induction heating. Using the "picture text" approach, the author covers such subjects as eddy currents, skin effect, reference depth, resistance of heating coil and heat flow in the workpiece. In Volume 2 he continues with a discussion of heating coils, motor generators, the induction alternator, three-phase rectifiers, and other related topics. Two valuable features are the review questions given at the end of each section and an inclusive glossary for easy reference.

RECOMMENDED PRACTICES FOR METALLIZING SHAFTS OR SIMILAR OBJECTS, PART 1A.—*By the American Welding Society, 33 W. 39th St., New York 18, N. Y. Price $1. 22 pages.*

One of a series written by the AWS to provide an authoritative source of information relative to the metallizing processes, this pamphlet presents a description of the procedures employed in metallizing cylindrical surfaces to restore size or provide specific surface characteristics. The application of metal in wire form by gas metallizing only is discussed in this manual.

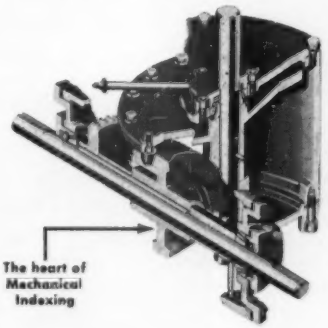
Why Index Mechanically



Important Features of Mechanical Transfer–

● SHOCK FREE TRANSFER OF MASSIVE LOADS

Made possible by cams designed and built to precise specifications to provide a high speed index or transfer motion with controlled acceleration and deceleration. Transfer is never free—it is always contained by a tapered follower in the tapered cam path.



● ACCURACY OF INDEX

No other means provides such a high degree of precision repeatability of index. Regardless of number of positions accuracy is maintained by two followers which straddle the dwell portion of the cam.

● SYNCHRONIZED TOOLING ACTUATION

Continued motion of the index cam shaft provides the power and basic motion for tooling actuation with positive mechanical interlock.

● INHERENT LOW MAINTENANCE

Standard Tool indexing equipment is practically maintenance-free due to its extreme precision manufacture and its carefully balanced components. Tapered roller bearings used throughout provide long durable service.

● TECHNICAL BOOKLETS

Fact-filled booklets showing indexing positions, tolerances, available dial and tooling plates, load ratings, dimensions and other information are available without cost. Standard Tool engineers will be pleased to assist you in selecting the indexing unit best suited to your particular requirements.

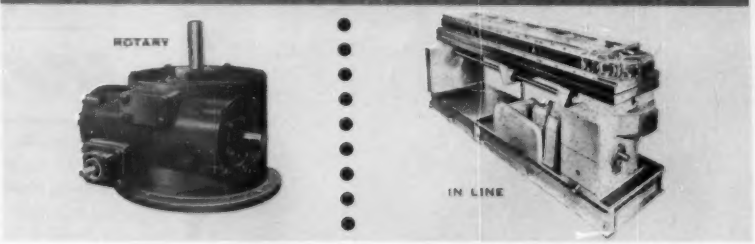
Better Products at Lower Costs thru Better Methods!

MACHINERY DIVISION

STANDARD TOOL & MANUFACTURING CO.

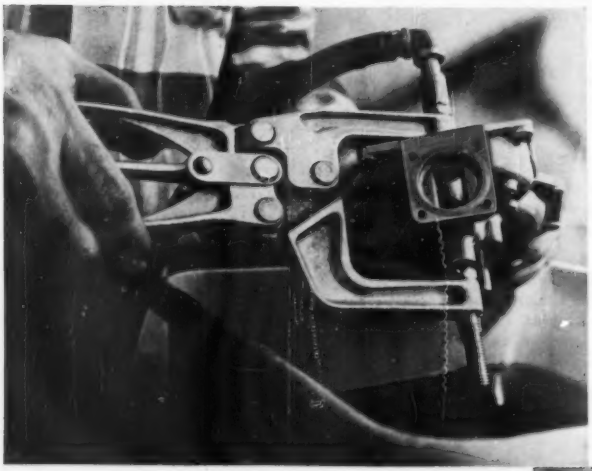
705 SCHUYLER AVENUE LYNDHURST, NEW JERSEY

SELECT FROM A FULL RANGE OF UNITS—IN LINE OR ROTARY



Use Reader Service Card, CIRCLE 83

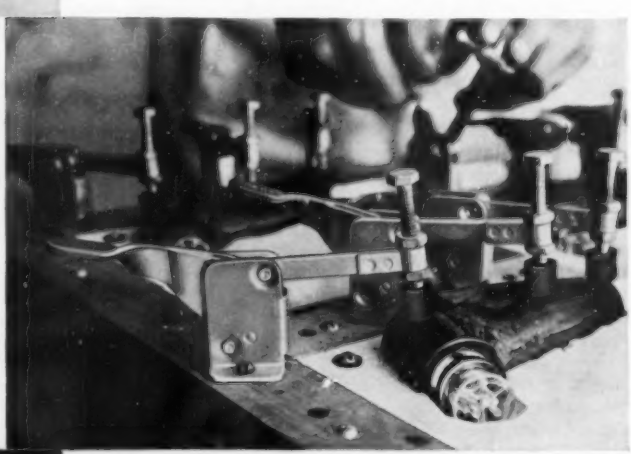
Look what clamps are doing!



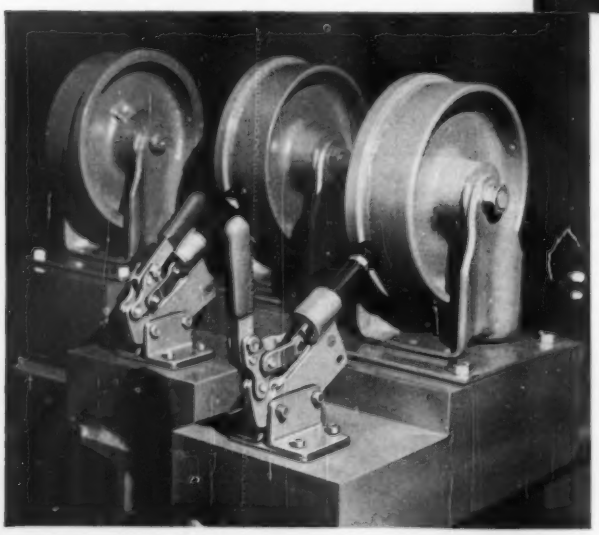
Practical uses of Wespo Toggle Clamps and Pliers that may suggest ways you can save

Toggle plier serves as low cost fixture for testing castings The air line is connected through one jaw of a Wespo Model 522 Toggle Plier. The plier is then clamped onto the casting and air applied by a foot control. Immersing the casting into a tank quickly spots any defects. Patented "Quick trigger" feature of the Model 522 instantly releases the casting; speeds testing. Rugged, lightweight Wespo toggle pliers are available in various jaw capacities and sizes.

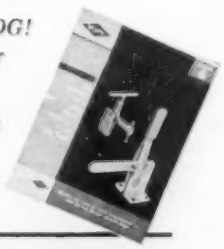
Holding these glued parts together while drying is a simple task with Wespo Horizontal Bar-Type Toggle Clamps. Neoprene-capped spindles prevent damage to plastic surfaces, yet securely hold the parts during the drying operations. Wespo toggle clamps are available in more than 80 types and sizes. So, the next time you think clamps, think Wespo!



Simple, low cost "parking brake" for this track-operated frame is provided by a Wespo Push-Pull Clamp equipped with a neoprene-capped spindle. "Brake" is quickly applied or released by a simple flick of the wrist. Wespo Push-Pull Clamps are available in various sizes and holding pressures and are ordinarily used on holding fixtures where push or pull clamping is required.



FREE CLAMP CATALOG!
Ask your Wespo distributor for your free copy of this 16-page Wespo catalog. It will help you quickly select the right clamp for every clamping job.



WESPO

DIVISION OF VLIER ENGINEERING CORPORATION
26935 W. Seven Mile Rd., Detroit 19, Michigan
Formerly West Point Manufacturing Company

Trade Literature.

for free booklets and catalogs—use request card, page 117

COMMON CONVERSIONS, such as inches to centimeters, watts to horsepower, etc., are included in a wall chart that shows many conversions that are difficult to locate in reference manuals. Precision Equipment Co. **(Circle 501)** . . . A line of flat spiral power springs—spiral, crosscurved, stainless and a new integral band type—is covered in a booklet. Reference data on spring nomenclature is provided. Sandvik Steel, Inc. **(Circle 502)**

Automation

Booklet "Power in Numbers" discusses how numerical control works and why companies are using it. An excellent introduction to this field. Norden Div., United Aircraft Corp. **(Circle 503)** . . . The facilities and services of the McDonnell Automation Center are described in an illustrated booklet. The services include data processing for scientific, administrative and industrial clients. Systems are designed for inventory controls, production scheduling, parts requirements and so on. McDonnell Automation Center, Div. McDonnell Aircraft. **(Circle 504)** . . . With standard "building blocks," machining operations can be added, changed or eliminated at low cost. LaSalle Machine Tool, Inc. **(Circle 505)** . . . A miniature power inserting tool installs small-size stainless-steel wire standard screw-thread and screw-lock inserts. Heli-Coil Corp. **(Circle 506)**

Broaching

Twelve-page brochure describes a four-way convertible broaching machine. The machine has a basic vertical design that can be arranged or converted for push-down, surface, pull-down and pull-up broaching. Sundstrand Machine Tool Co. **(Circle 507)**

Die Casting

Bulletin describes line of high-pressure hydraulic die casting machines. Various models from 100 to 2000-ton capacities are available. Machine automation and vacuum die castings are optional features. Cleveland Automatic Machine Co. **(Circle 508)**

Fasteners, Fastening

"Screw Descriptor" with two revolving dies supplies correct nomenclature when selecting screw products. Write Dept. 279, Active Screw & Manufacturing Co., 4250 N. Pulaski Rd., Chicago 41, Ill . . . Up-dated review of line of self-locking standard nuts and clinch nuts. Standard Pressed Steel Co. **(Circle 509)**

Finishing, Grinding

Illustrated catalog describes flat surface grinding and polishing machines for finishing and deburring sheets, bars, strips, coils, stampings, forgings and castings. Acme Manufacturing Co. **(Circle 510)** . . . Vertical machines for standard and contour grinding, turning, boring and other machining operation are illustrated in a brochure. Data on tracer or numerical control of these machines, standard features and optional equipment is included. Frauenthal Div. **(Circle 511)** . . . Advantages of Microstoning—a process in which stones are oscillated against moving workpieces to control roundness and finish—are covered in a catalog. A stone-selector guide is included. Taft-Peirce Mfg. Co. **(Circle 512)** . . . Detailed results of tests performed on the correlation between particle shape and efficiency in resin-bonded diamond grinding wheels are reported in Vol. 1, Nos. 7-8, of *Diamond Data*. Engelhard Hanovia, Inc. **(Circle 513)** . . . Portable grinding tools and small hole drilling equipment are described in a catalog that explains applications for tool post grinders, flexible shaft tools, quills, microdrills, high-speed drill presses, automatic drill heads and other items. Dumore Co. **(Circle 514)**

Fluid Power

Bulletin offers general and technical information, dimensions and specifications on a new interchangeable, high-pressure square-head hydraulic cylinder. Tomkins-Johnson Co. **(Circle 515)** . . . Catalog presents specifications on a line of 3000-psi hydraulic cylinders. Pathon Manufacturing Co. **(Circle 516)** . . . Portable air tools, self-feed drilling units, air hoists, power motors, special tools and accessories are described in a 96-page catalog. Aro Equipment Corp. **(Circle 517)**

Gearmaking

An illustrated brochure describes a 3-inch, fine-pitch gear shaper. Fellows Gear Shaper Co. **(Circle 518)** . . . A brochure gives specifications of a high-speed hobbing machine. Fellows Gear Shaper Co. **(Circle 519)**

Inspection, Measurement

Five brochures give details on optical comparators, including 30-inch screen extended range comparators, standard 30-inch screen comparators, 14-inch screen models and a 10-inch screen optical comparator and measuring machine. Jones & Lamson Machine Co. **(Circle 520)** . . . Gear inspection machines are described in a catalog. These include gear rollers, gear speeders and an involute profile checking machine for gear shaving cutters. National Broach & Machine Co. **(Circle 521)** . . . Catalog 520 describes dial indicating receiver gages. These are low-pressure gages used to indicate values transmitted by a pneumatic signal from a remote location. United States Gauge. **(Circle 522)** . . . Application, operation and versatility of the Rototester for detecting flaws in cold-drawn coiled wire are reviewed. The eddy-current techniques is used. Magnetic Analysis Corp. **(Circle 523)** . . . Bulletin on magnetic particle inspection of steel castings discusses various processes and equipment and the relative costs. Lebanon Steel Foundry. **(Circle 524)**

Lathes

Details of the Bryant Symons precision diamond tool lathe are given in bulletin. Chapters on surface finish and applications are included. Milo Manufacturing Co. **(Circle 525)** . . . Three bulletins describe in detail a ram type turret lathe with multispeed hydraulic headstock, a saddle type turret lathe with multispeed headstock and an automatic turret lathe. Jones & Lamson Machine Co. **(Circle 526)** . . . A new turret

lathe is equipped for turning, chucking and single-point threading in addition to standard turret operations. Sheldon Machine Co., Inc. **(Circle 527)** . . . Twelve-page bulletin covers a heavy-duty engine lathe with a 180 cu in. per min metal-removal rate. Sidney Machine Tool Co. **(Circle 528)** . . . Lathes in a new line have bridge-bed designs. A variety of versions are available—a 30-60 automatic tracer; a 180-deg automatic tracer, and a multiple-slide automatic lathe. Jones & Lamson Machine Tool Co. **(Circle 529)**

Materials

Characteristics and typical applications of Pyrotem (prehardened) and Pyroneal (annealed) hot-work die steels are given in a data sheet. Heppenstall Co. **(Circle 530)** . . . Alloy No. 25 and Alloy C are described in detail in separate booklets. These give the latest information on tensile data, welding and other characteristics of these alloys. Haynes Stellite Co. **(Circle 531)** . . . Treating and metallurgical data and a tool steel selector guide are covered in a 144-page tool steel catalog. Darwin & Milner, Inc. **(Circle 532)** . . . Data sheet gives information on laminating and casting epoxies that cure at room temperatures. Rezolin, Inc. **(Circle 533)** . . . A 4 x 8-inch slide rule tells in seconds how each of eight types of metal withstands the corrosive effects of 141 chemical agents. H. M. Harper Co. **(Circle 534)** . . . Characteristics and applications of a chromium-molybdenum-vanadium alloy die steel for hot forging applications are contained in data sheets. Heppenstall Co. **(Circle 535)**

Milling

Over 1800 standard sizes and types of end mills are illustrated and described. Putnam Tool Co. **(Circle 536)** . . . Three bulletins describe new vertical head, bed type milling machines, medium-duty knee type milling machines and ram head milling machines. Kearney & Trecker. **(Circle 537)**

Motors, Controls, Drives

Quick-Selector guide automatically gives the correct model speed reducer for any combination of input speed, ratio or output speed and required capacity. Foote Bros. Gear and Machine Corp. **(Circle 538)** . . . Catalog describes and illustrates mechanical power transmission equipment — variable speed drives, V-belt drives, timing belt drives, pulleys, couplings and other components. T. B. Wood's Sons Co. **(Circle 539)** . . . Automatic protection against die and press damage is explained in a bulletin that describes a press overload detector that works with presses at 1000 spm. Wintriss, Inc. **(Circle 540)**

Painting, Plating, Marking

An illustrated catalog describes electroplating, polishing and spray painting equipment and supplies. J. Holland and Sons, Inc. **(Circle 541)** . . . A complete line of machines and tools for indented marking is covered in a catalog. Individual sections deal with roll marking, press stamping, hand stamping, graduating, marking dies and tools. Noble & Westbrook Manufacturing Co. **(Circle 542)**

Pressworking

Single-action, straight-side, single-crank presses are available in sizes from 60 to 400 tons. Federal Machine and Welder Co. **(Circle 543)** . . . Automatic roll feeds for material from 2 to 16 inches wide are described in a brochure. Durant Tool Co. **(Circle 544)** . . . Eight-page bulletin helps engineers to evaluate the merits of a power press designed for cutting off roll-formed shapes on the fly. Federal Press Co. **(Circle 545)** . . . Bulletin No. SS-60 describes the principal construction features and gives general specifications of straight side type press brakes, both closed-frame and gap frame. Dreis & Krump Mfg. Co. **(Circle 546)** . . . Advantages of standard punches are explained in a catalog that also gives specifications and engineering data. Dayton Perforators, Inc. **(Circle 547)**

Threading

Application booklet illustrates and describes applications of a thread rolling machine that can employ the infeed, through-feed or continuous feed methods as required. Landis Machine Co. **(Circle 548)** . . . Bulletin covers a new automatic thread milling machine. An infinitely variable range of thread leads up to ½ inch can be cut. Settings are made by a dial control. Sundstrand Machine Tool Co. **(Circle 549)**

Welding

Reprint of article entitled "Specific Problems Associated with Oxygen Cutting of Bevels" discusses the relationship of preheat, cutting oxygen and speed and the practical techniques for obtaining good-quality bevel results. Air Reduction Sales Co. **(Circle 550)**

ALINA
SERIES "W"
BORE GAGES
Range from .160" to 12"

Alina bore gages are extremely sensitive and designed for trouble-free operation.
The three point centralization system locates the gage in the hole quickly and accurately.
Alina bore gages will swiftly reveal taper, bell mouth, out of round, and other dimensional variations.
A push-button retracts the movable anvil for easy non-scratching insertion into the workpiece. This feature also saves wear on the anvils.
Each gage is equipped with tungsten carbide contact points for lasting on the job accuracy. (except model WO-1).
Bore gages with measuring depths up to 40" delivered on special order.
Model WO-1 available with measuring heads down to .160".
Furnished as a set complete with depth adjustment stops and fitted wooden case.

WRITE FOR ILLUSTRATED LITERATURE
ALINA CORPORATION
122 East Second Street, Mineola, Long Island, New York
Use Reader Service Card, CIRCLE 85

technical shorts

Resistance of carbon steel to heat corrosion and wear can be increased by "Alphatizing," a new method of chromium diffusion. The process is not a form of plating or coating since the chromium applied produces a true alloy within the surface of the base metal.

Process Case Hardens Tool Steel

Use of the process enables manufacturers to specify the degree of hardness, weldability and ductility required in tool components. Normally, mild or low-carbon steels show greatest chromium penetration. In treating air-hardening steel a variation of the process is required to effect core hardening although conventional heat treat furnaces are used for all types of steel.

* * *

A new automatic training machine which utilizes automation techniques to retrain people who themselves are being displaced by automation, has been developed by USI Robodyne, a division of U. S. Industries, Inc. Called "Digiflex," the new equipment takes advantage of man's conditioned reflexes to speed the learning of manual skills.

Training Machine Utilizes Automation

Invented by Edwin F. Shelley, president of USI Robodyne, and John Goodell, director of engineering, the Digiflex trainer simulates the keyboards required to operate office and industrial automation equipment. It makes use of a simple human reaction: when a person's finger is pushed up, reflex action will automatically cause him to try to push his finger down again. By reinforcing this instinctive reaction, Digiflex drastically reduces the length and difficulty of the learning period.

The first commercial application of Digiflex was designed to meet the specific training needs of the U. S. Post Office Dept., where operators of new automated mail sorting equipment must channel letters to appropriate sorting bins. Geared to this type of teaching need, Digiflex teaching equipment consists of three principal elements: an instructor's station, a student's station and a special strip-film projector and related magnetic-tape sound system. One instructor's station can be linked electronically with as many as twenty student's stations. Stations bear a general resemblance to office desks, with small sections housing the complicated electronic equipment. The instructor's station contains a console panel incorporating all the controls necessary to govern operations of the teaching facilities.

When the projector flashes an address on a screen, an electronic impulse notes the appropriate code number and raises appropriate keys on each of the student-station keyboards. Simultaneously it produces the code number audibly. When the keys are raised on each student keyboard, reflex action causes the fingers to depress those keys. In a relatively short time, the proper figner response is automatically and permanently established for the student.

MAGNA-SINE *(Magnetic)*

SINE PLATE *(Non-Magnetic)*

Speed, Accuracy, Savings on Every ANGULAR SET-UP

Robbins Angular Tooling Equipment Now Manufactured by EX-CELL-O

You can save hours of set-up time and be certain of accuracy on your angular grinding, other machining, and inspection operations with Robbins Magna-Sines and Robbins Sine Plates.

Any desired angle can be quickly and easily set up by using standard gage blocks. Referring to the handy Table of Constants supplied with each unit, it is simple to select the proper blocks. Accuracy of the set-up is then always to the gage block limits.

This simple, fast, sure method sets up all angles, single or compound, right or left hand, without V-blocks, angle plates or complicated "build-ups". Complete range of models and sizes in both magnetic and non-magnetic types puts Robbins precision equipment within the reach of every shop. Write now for complete catalog.

9082

EX-CELL-O CORPORATION

Greenville Plant, 945 E. Sater St., Greenville, Ohio

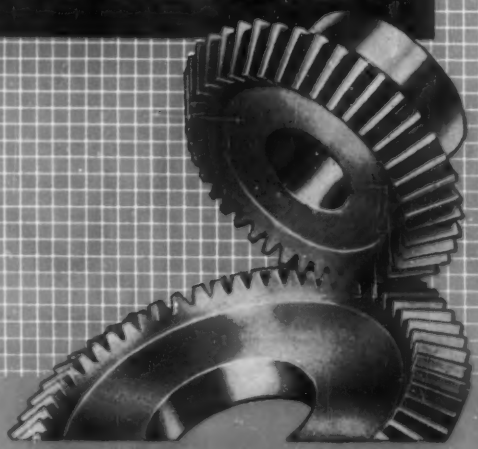
EX-CELL-O FOR PRECISION

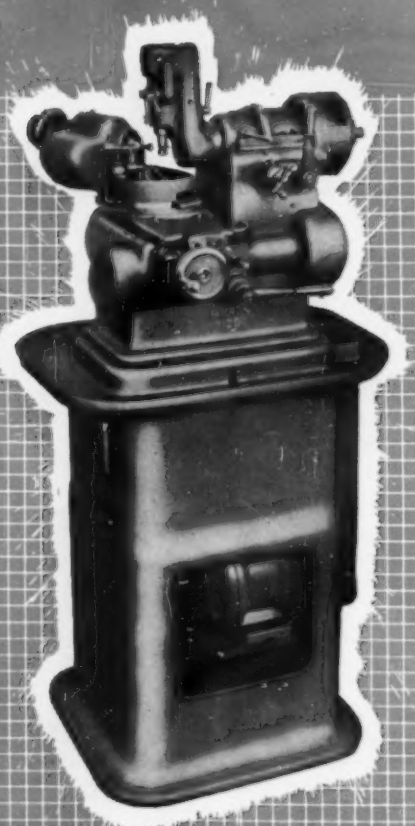
MANUFACTURERS OF PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • CONTOUR PROJECTORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Use Reader Service Card, CIRCLE 86

THE ULTIMATE IN

BEVEL GEAR ACCURACY





• low-cost tooling
• simplicity of set-up

NO. 120 MIKRON

fine pitch
BEVEL GEAR HOBBING MACHINE

RUSSELL, HOLBROOK & HENDERSON, INC.

292 Madison Avenue
New York 17, N. Y.

2840 Supply Avenue
Los Angeles 22, Calif.

TOOL ENGINEERING in Europe

By M. Kronenberg
Consulting Engineer
Cincinnati 6, Ohio

Precision Boring Defects

Cutting force has the greatest effect on the true hole shape and dimensions in the precision boring of steel according to P. H. Brammertz, writing in *Industrie Anzeiger*, Vol. 82 (46), 1960, p. 718-726. His article is titled: "Ursachen fuer Form—und Maassfehler beim Innen Feindrehen." The author has examined the accuracy obtained in internal boring operations under various conditions of metal removal, speed, feed and tool geometry. Cutting force can deflect the lathe spindle and displace it out of the true running condition and thus distort the shape of the work. The clamping of the workpiece greatly affects the cylindrical shape, while the dimensional accuracy depends on the wear of the tool. Surface finishes change with variations in cutting conditions.

Finishing Carbide Tools

Synthetic diamonds have often substantial advantages over natural diamonds in the grinding and lapping of carbide tools, says B. Kleinschmidt, writing in *Metall*, Vol. 14 (6), 1960, p. 567-569. The title of his article is: "Fortschritte beim Schleifen und Laeppen der gesinterten Hartmetalle." According to the author, the chief advantages of Bakelite-bonded synthetic diamond wheels are longer wheel life, faster grinding, reduced cutting pressure and sharper cutting edges. He also says that diamond tools—sintered diamond pencil honing tools, for example—offer new possibilities for mass production, particularly for machining cast iron and steel. For removing large amounts of stock in bores, it is often feasible to use electrolytic diamond honing tools. Small holes can be machined with hones having a layer of diamonds directly on the tool shank. Plastic-bonded diamond wheels run cooler than diamond wheels bonded with other materials.

Honing and Superfinishing

An article on honing operations—"La honage et la superfinition" by A. Dessart—appears in the Belgian magazine *L'Usine Belge*, Vol. 37 (1674), 1960, p. 6-10.

The honing process and its most satisfactory applications for German and Belgian machines are discussed. Superfinishing is used in two ways: with an abrasive that removes only protruding particles from the surface of the workpiece and ceases to abrade once they are removed, and with an abrasive that continuously abrades and thus sharpens itself. The first method is particularly adaptable to internal and plunge grinding; the second method is superior for other operations. A dull surface is obtained with the second method, requiring a finishing process with special wheels containing a graphite abrasive.

Hot Machining

What is apparently a modification of the hot machining processes has been developed by two Chinese engineers (names not given), according to a short article in *New Scientist*, Vol. 8 (189), 1960, p. 1644. They use two cutting tools, one on top of the other. The upper tool performs a roughing operation and the lower tool smooths the hot surface. Heating is produced by an electric current that passes through the tool tip and the work surface. The tools are apparently cooled with a carbon dioxide spray. The reduction in cutting force is 25 percent, a low value in comparison with tests run by this writer, who found reductions up to 50 percent.

Electronic Drives

The cost of the electrical and electronic equipment for a modern machine tool may amount to 20 to 50 percent of the entire cost of the machine. Eugen Huber, in an article entitled: "Werkzeugmaschinen Antriebe mittels elektonischer Steuerungen," considers all aspects of electrical and electronic equipment. His article appears in the Swiss magazine *Industrielle Organisation*, Vol. 29 (8), 1960, p. 321-340.

The purpose of the article is to make tool engineers more familiar with the problems involved. The author has divided the article into two sections; the first is devoted to electrical equipment; the second, to electronic. A thorough discussion of drives is followed by chapters dealing with a-c three-phase motors and d-c motors. The most important equations governing their operations are given. Transformers, both rotating and stationary types, are explained by means of circuit diagrams. Transducers, magnetic amplifiers and transistors are covered at some length.

In the section dealing with electronics the author starts with the closed loop, introducing the most significant mathematical relationships and explaining the methods of transforming differential equations into algebraic equations by means of the Laplace transformation. In addition, he covers the operation of electronic devices and presents illustrations showing various designs.

The application of electronics to the main drive for lathe spindles and planer tables is discussed. Cutting force, cutting speed torque, metal removal rates and other factors are taken into consideration. The last part of the article covers electronic circuits for controlling a turret lathe, a crankshaft grinder, a planer, and so on; also devices for limiting and maintaining speeds.

Subzero Machining

Subzero machining at ultrahigh speeds is a promising method of improving present-day machining techniques. K. Th. Preger reports on tests he has run in an article published in *Werkstatt und Betrieb*, Vol. 93 (8), 1960, p. 479-482, under the title: "Kuehl-Zerspanung." The author refers to ultrahigh-speed machining tests conducted in the United States. He believes that subzero machining results in reduced cutting temperatures and reduction of the cutting forces. In his tests liquid air was used to cool the work material to temperatures of about —300 F.

In preliminary tests it was found that the increase in temperature of workpieces due to machining is slow enough to carry out subzero operations. The temperature increase depends primarily on the ratio of the surface of the workpiece to its volume. Cutting forces and cutting temperatures dropped when subzero cooling was used and the results indicate that it is possible to increase the maximum cutting speed about 100 percent. Chip formation was substantially changed. Chip thickness was reduced considerably, indicating a larger shear angle and better cutting performance. The microstructure of the chips differed considerably. Chips cut at room temperature had interlocked shear planes, rather close together, while the individual chips cut at low temperatures were segmented.

If it should be possible to apply subzero cooling to machining at ultrahigh cutting speeds, it appears that a new field could be opened to the metal processing industries. The advantages of the subzero cooling are not limited to increases in cutting speed and reduction of temperatures, but also include improvements in tool life and surface finish, and easier cutting of difficult-to-machine metals.

Meeting the strict specifications of National Aircraft Standards, New York's Type A, B and C twist drills are specially designed for heavy duty drilling. Their sturdy construction and precision points last longer and give greater production ...Best of all, you pay no premium for these special types.

Other special heavy duty drills featured in the New York line are made for drilling heat hardened aluminums, 75ST, Titanium, Inconel X, 17-7, 19-9 and other tough and abrasive alloys. They bite in clean and easily, giving more holes, all perfectly round and on size.

Remember, New York saves money on your twist drill bill and you get top quality work every time! If you wish further information, one of our sales engineers will be glad to call on you.

NEW YORK TWIST DRILL COMPANY, INC.
278 Lafayette Street, New York 12, N.Y.
MIDWEST OFFICE:
30-A N. Clinton St., Chicago 6
WESTERN OFFICE:
3537-A E. Olympic Blvd., Los Angeles 23

Electrocontact Machining

Machining of high-temperature alloys is often limited by the properties of the tool materials. Considerable work to overcome these difficulties has been done at the Enims Institute in Moscow, according to an article published in *Stanki i Instrument*. The authors are M. E. Yukhvid and A. T. Kravets. The article is translated into English in *Machines and Tooling*, Vol. 31 (5), 1960, p. 18-21.

Results obtained when machining rotating surfaces by the electrocontact method are given. In this method, the turning tool is replaced by a rotating disk, running at a peripheral speed of 7000 to 8000 fpm, comparable to the velocities used in cylindrical grinding operations. Electrical current is delivered by a 380-v transformer with a secondary voltage range between 5 and 32 v. This low-voltage current is passed through the rotating disk and the workpiece, producing an electric arc that removes metal.

It was found that the direction of rotation of disk and workpiece had a considerable effect. When the wheel and the work were rotating in opposite directions (and hence in the same direction at their contact area, just as in the case of two gears) hot metal particles were found welded to the machined surface, making those surfaces unacceptable. When the direction of rotation of either one of the rotating bodies was changed, the hot chips were welded to the unmachined surface. Since these chips were removed by the following turn, their presence was not objectionable.

The investigation was primarily concerned with determining the most effective profile of the wheel, the selection of feeds and speeds for lowest energy consumption and with the evaluation of the heat effect on microstructure and microgeometry. A straight cylindrical wheel, corresponding to a side-cutting edge tool in turning, was not satisfactory, due to short circuits. A tapered wheel, corresponding to a lathe tool with a side-cutting edge angle, performed satisfactorily. The electrical energy consumption was affected by the chip cross-sectional area but not by the chip cross-sectional shape. The effect of the cutting speed of the workpiece is represented by a curve having a minimum at a certain speed, depending on the chip cross sectional area. This minimum is attributed to heating.

A number of equations for calculation of the power of the electric arc, average wheel temperature, heat radiation and other quantities affecting the process appear in the article. Experiments by the authors have shown that intense water cooling is necessary to maintain the proper wheel temperature. The heat effect on the microstructure of high-temperature alloys penetrated only to a depth of about 0.010 to 0.020 inch. Depth of the molten layer depends upon the initial properties of the work material, and is greater in cases where the heat conductivity is greater than that of high-temperature alloys. Details regarding martensite formation and ferrite formation are given. The microhardness increased from 312 to 396 and the machining costs were reduced to one-half or one-third of the cost of conventional cutting methods.

Jig Borer Rigidity

The rigidity of a jig borer depends to a great extent on the foundation on which it is mounted. The mounting affects the positioning accuracy considerably, according to investigations reported by V. V. Kaminskaja and F. A. Frantsuzov in *Stanki i Instrument* and translated into English in *Machines & Tooling*, Vol. 31 (5), 1960, p. 25-27. Their article is entitled: "The Effect of Foundation Mountings on the Rigidity of Single-column Jig-Boring Machines."

Maximum deflections occur when the table is traversed in its length direction and it was found that 80 to 90 percent of the error occurred in the X-axis (lengthwise through the table). Bed deformations have the greatest effect on the coordinate setting accuracy (70 percent); these in turn depend on the machine mounting.

The authors discuss tests which they have run in which the number of support points and their locations have been changed. On one jig borer, the angle of deflection for three support points, one in front and two at the rear, was taken as the reference angle (=1). The deflection decreased to 0.6 when four additional supporting points were used—two near the X-axis and two closer to the front. The conditions were, however, very different on another jig borer that had a different base. Again taking the three-point support as "1," the deflection was reduced to 0.55 when two more supports were added at the middle of the bed and another at the front. Removing all these support points, leaving only two at the front and one support point at the rear, gave the best result and reduced the deflection to 0.35.

Three support points are sufficient to ensure minimum elastic deformation of the bed of a single-column jig borer when the last-mentioned distribution is used. More than three points make the system statically indeterminate, although in some of the cases described the additional supports points reduced the deflection. Torsion is also considered and formulas are given.

Process Control Programming

Technological evolution of the digital computer has produced another type of machine, distinct from its scientific and business forerunner—the real-time control computer. Its function is to monitor and control complex operations and activities as they take place (real-time). Development of the first real-time computers were government sponsored, for air defense. More recently computers have been developed specifically to control industrial processes in real time. At present, there are three production-line process control computers. (Ramo-Wooldridge's RW-300 at Texaco, B. F. Goodrich and Monsanto). The inevitable widespread use of computers as an integral part of controlled processes makes it mandatory for engineers to become familiar with these devices and with real-time programming.

Digital computers vary as a function of their design objective. Any computer is composed of four basic units: (1) the memory unit to contain instructions and data; (2) arithmetic unit to perform necessary calculations; (3) input-output unit, the means by which information is inserted into and received from the computer; (4) the control unit, or traffic cop of the computer that calls out instructions and commands and operates the computer.

A computer designed for real-time control requires as its design objective high reliability, low cost and sufficient memory to control the process. The memory unit is generally adequate to solve the problems for which it is designed. The arithmetic unit and control unit are generally simple and reliable. The input and output unit is distinguished by its flexibility. Programming a process control computer requires special considerations. Normally, digital computers are given problems to solve and in scientific and business problems, the solution terminates the problem. In real-time process control, when a solution is found, it becomes merely an input to another problem, which in turn has another solution, and so forth. This could go on continuously, but the operator would not know how frequently the computer was reading in process data since calculation time can vary. So the real-time process computer is tied directly to a clock and programmed to come up with a new solution to the process control equation at distinct intervals. Super-imposed on the timing requirements for control are the demands for periodic scanning of key variables, logging on a scheduled basis, stepping and reading of analytical instruments on a minimum schedule and performance of operator request. Effectiveness of the control system depends on scheduling the program.

A group of programs to control or process can require over 3000 instructions. But these programs, once completed will operate year after year, as long as the process exists. The number of executions of a process control system can easily exceed a half million. Thus, the ratio of program operation time to programming time is tremendous. If changes or modifications occur in the process or equations, these can be changed in the program, providing the system is suitably designed initially.

The control program must also be designed to detect failures of instrumentation. Typically this would be reaction temperature, flow pressure, and so forth. If trouble is detected the program must be designed to take quick action in the right direction and sound an alarm for the operator. Since the reaction time of the digital computer is almost instantaneous, it can prevent these emergencies by early detection and quick action would take minutes for a human operator. The process control program must also be capable of checking components of the system external to the computer as well as within the computer itself. Since the computer performs, say, 400 calculations per second, it is impossible for a human being to keep track of its operations and accuracy. No computer will be completely error free over long periods of time. To build hardware adequate for checking the computer would cost excessively. Therefore it is left to the computer program to build in reliability checking performance. As mentioned, changes can occur in a program. Improvements will usually be made in a process because of advances in process knowledge. Since the logging function of the computer is to supply reliable consistent data for process analysis, improvement will usually come more frequently than under conventional control. The process control programmer must be aware of the ease-of-modification requirement while designing the control scheme. Certain guides help the programmer achieve these ends. They are: (1) design the program to follow particular paths of operation based on a sequential list of control words. This allows alternatives in program operation by changing a few words; (2) all independent functions should be programmed as separate subroutines under the control of a master, executive routine. Changes in operation can be made by modification of the executive routine. If changes must be made within the subroutine, they can be made without affecting other subroutines; (3) avoid multiple use of constants by different parts of the program; (4) avoid trickiness in programming; (5) document the program completely including flow diagrams, listings, storage maps and routine descriptions. This could run about 200 pages of detailed information.

From "Programming for Process Control" by Emil R. Borgers, Thompson-Ramo-Wooldridge Products Co. Presented before AIEE Joint Automatic Control Conference. Available from American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

Future Trends

Eight specific points can be indicated as affecting us during the next ten years.

1. There will be a net addition of about 27 million persons to the population by 1970.
2. There will be more money to spend. Average earning will rise 2.9 percent per year, from $2700 to 3600 per person, based on the 1958 dollar
3. There will be more leisure time. The average work week declines 1.5 hours during each decade.

4. Total productivity will increase. Expressed as gross national product, we should rise from the $500 billion level to about $800 billion
5. Accelerated technical research will bring improved and new products
6. Development of new products is transforming our most traditional activities.
7. People develop greater confidence in their ability to solve problems.
8. Technological improvement in underdeveloped countries is creating world markets.

These six basic elements will affect various activities during the next decade: food, shelter, energy, transportation, communication and power.

Food is becoming more and more prepared, requiring a minimum of work to put it on the table. Prefrozen meals, prepackaged meals and cooked meals will be seen in greater quantities. Shelter should change considerably. The construction industry anticipates that during the next 40 years the United States will build the equivalent of an entire new nation at a cost of about a trillion dollars. Energy sources should change. It appears that there is abundant radiant energy from the sun to heat and cool houses in roughly 85 percent of the living areas in the U. S. Solar batteries could develop sufficient power from the sun's rays to operate home appliances. Thermoelectric devices will probably make housekeeping easier and more economical. In the industrial field more and more plants will become environment controlled because of the increased use of delicate controlled devices. Transportation is moving people and goods faster. For the first 3000 years of our history, from 1500 B.C. to 1830 A.D., man's fastest vehicle traveled at 30 to 35 mph, the speed of a horse. By 1945 speed increased to 470 mph. Since that time, in 15 years, the speed of man-made vehicles has increased to 18,000 mph. Batteries may provide economical, noiseless, odorless vehicles. Ducted fan vehicles riding air over land and water will increase in use. Communication speed is increasing, and reaching more places, since the development of radio, radar, television and radio-telescopy. World-wide radio-telephone service should become available and from it interchange of graphic materials—engineering drawings, blueprints, photographs and so forth. Machine translation of languages should develop more and increase the flow and exchange of technical and scientific information. Power needs are increasing and will be satisfied. As muscle power is replaced by electricity, electric consumption will probably double in the next ten years. Automation is adding brain power to the ability of human brains to produce. As atomic power spreads, factories will be built close to their markets. Solar energy will become an increasing energy source for this power.

In the next decade, peace is more and more essential as it becomes increasingly difficult to isolate any one society and its economy from the world around it. Time is collapsing—if, with Mr. J. Lewis Powell we rescale man's 50,000 years on this planet to 50 years, (a time-span more comprehensible to most of us) then 10 years ago man stopped living in caves. Five years ago picture writing was invented. Ten days ago electricity was discovered. On this scale almost everything that makes up our material world from inside plumbing to jets and missiles has been invented in the last 24 hours. The burden upon the individual is increasing. He must be able to accept a rapid transition in the physical world and yet maintain personal stability. He must increase his education to keep up with technology advances and himself become more creative.

From "Formula For The Future" by Robert A. Sandberg, Kaiser Aluminum and Chemical Corp., presented before the Cleveland Engineering Society, 3100 Chester Ave., Cleveland 14, Ohio.

TO REQUEST COMPLETE PAPERS WRITE TO THE ADDRESS AND ORGANIZATION INDICATED AT THE END OF EACH ABSTRACT

SKIN MILL CONVERSION FOR AIRCRAFT BLDR.
PLANER CONVERSION FOR AIRCRAFT HONEYCOMB
LATHE CONVERSION
FOR MISSILES
GANTRY MILL CONVERSION
PLANER CONVERSION FOR NOSE CONES
PLANER CONVERSION FOR EXOTIC METALS
CONVERSION FOR
ALL MAKES OF SURFACE GRINDERS
HYPODERMIC NEEDLES
FOR ORIG. EQUIPT MFGR.
FOR SPECIAL ROTARY GRINDER FOR JET BLADE MFGR.
DENTAL DRILLS
FOR "RISE AND FALL" MILLER

In SPINDLES for electrolytic metal removal

...*"We build a better mouse trap" EVERY DAY!*

The "mice" we're after of course, are the thousand-and-one special problems that plant engineers from all over the nation bring to us for solution. In missile, aircraft and general manufacturing, we're batting 1.000!

We think it's because we're "old timers" in this new field. We can solve your problem today because we solved one like it yesterday.

SKETCH IT OUT • SEND IT IN WE'LL PROVE IT!

STANDARD
Super-Precision Spindles have CONVERTED.
Planers • Lathes • Milling Machines
Gantry Mills • Tool and Cutter Grinders
Surface Grinders
Special Machinery

STANDARD Super Precision Electrolytic Spindles are available in 50 to 3000 AMP Capacities.

Write for Catalog today

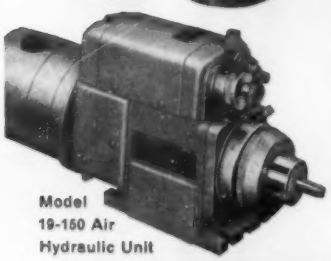
U. S. Patent No. 2946731

the STANDARD electrical tool co.
PRECISION SPINDLE DIVISION
2499 RIVER RD. • CINCINNATI 4, OHIO

Use Reader Service Card, CIRCLE 90

A CASE-HISTORY REPORT

Production Time and Cost Reduced 80%
Product Quality Improved with
HARTFORD SPECIAL Air Hydraulic DRILL UNITS



Model
19-150 Air
Hydraulic Unit

PART:
Hydraulic
Control Sleeve

MATERIAL:
8617 Steel

REQUIRED:
78 Accurately
Located Holes,
Drilled at
60° Angle.

The Char-Lynn Company, of Minneapolis, Minnesota, is a well-known manufacturer of hydraulic equipment for farm machinery. Rapidly increasing demands for the Char-Lynn Power Steering Unit made it necessary for this company to increase its production rates for components like the control sleeve shown here. To accomplish this, Char-Lynn switched from single spindle machines to two- and six-spindle machines assembled from Model 19-150 Air Hydraulic Drill Units and other standard components produced by The Hartford Special Machinery Company. As a result of this change-over, drilling time for the 78 holes required has been cut from 42-84 minutes to 9-10 minutes . . . and per-piece costs have been cut from $5.65 to $1.80! Smooth operation with "no-surge" break-through has eliminated burring, so scraping is no longer necessary. Maintenance is only about one sixth of that previously required, and there have been no breakdowns that weren't "man-made."

Low-cost, high-production machines, assembled from standard Hartford Special Drill Units and custom-engineered to specific job requirements, provided the right answer to Char-Lynn's time- and cost-cutting needs—and they can do the same for you. Write today for complete information, outlining your parts production requirements.

HARTFORD Special

THE HARTFORD SPECIAL MACHINERY COMPANY
3800 COLLEGE HIGHWAY, SIMSBURY, CONNECTICUT

Thor

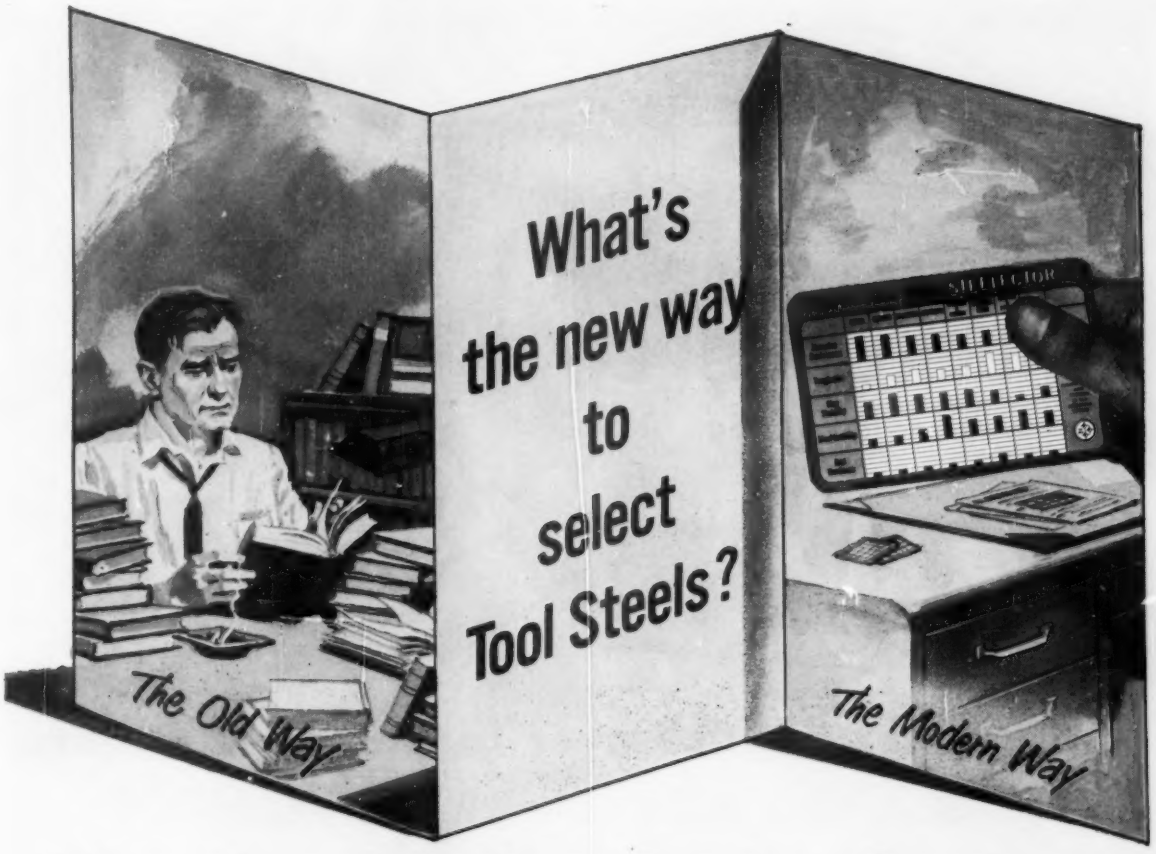
Everything you want in Multiple Nut Setters...

and more!

Speed production, multiply profit on any assembly of two to twenty-two nuts or screws. Thor multiples are custom engineered to your exact assembly situation. All fasteners are secured simultaneously to identical torque. Thor multiples can be engineered for any pattern, any product. Thor multiples are now in use in the assembly of such widely diversified products as floor mops and carburetors. Write today for Thor's complete automation manual on multiple fastener settings.

Thor Power Tool Company, Aurora, Illinois. Branches in all principal cities.

Thor POWER TOOLS



Use the A-L Steelector System

The man on the right is using the new way. With the new Allegheny Ludlum STEELECTOR he can select tool steels virtually at a glance. Best of all, he knows that his first choice is in stock—available right when he wants it. No longer does he have to waste hours looking through handbooks and catalogs only to find that he has selected a brand that is unavailable . . . or entails expensive delays because he must wait for the mill to make it.

With the STEELECTOR, picking the proper tool steel is an easy job. All you have to do is look at the STEELECTOR Card designed for the job at hand. There are STEELECTOR Cards covering general purpose tool steel applications, hot work applications, and high speed grades. A glance at the card compares the five basic tool steel properties—abrasion resistance, toughness, size stability, machinability, and red hardness—of each of the STEELECTOR tool steel grades.

Bar graphs show how the steels compare so it's simple to check the properties most important to you and pick the grade with the combination of properties you need. The three STEELECTOR Cards list grades that will suit 96 percent of all tool steel applications—as shown by an actual survey of the authoritative A-L Tool Steel Handbook.

Backing up the STEELECTOR Cards are Data Stock Lists for every grade. They list the complete necessary range of sizes and shapes available and typical applications. They also include heat treating and other data to assure you that you have made the proper selection.

You can put full confidence in STEELECTOR grades because they have been selected from the complete line of A-L Tool Steels and are made under the rigid quality control standards common to all A-L products.

To take the guesswork out of tool steel selection, ask your Allegheny Ludlum sales representative for your copy of a colorful STEELECTOR Bulletin that contains all three STEELECTOR Cards, describes the tool steels, and explains the Data Stock Lists, or write: ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. TE-12.***

STEELECTOR PROGRAM

ALLEGHENY LUDLUM

Tool Steel warehouse stocks throughout the country

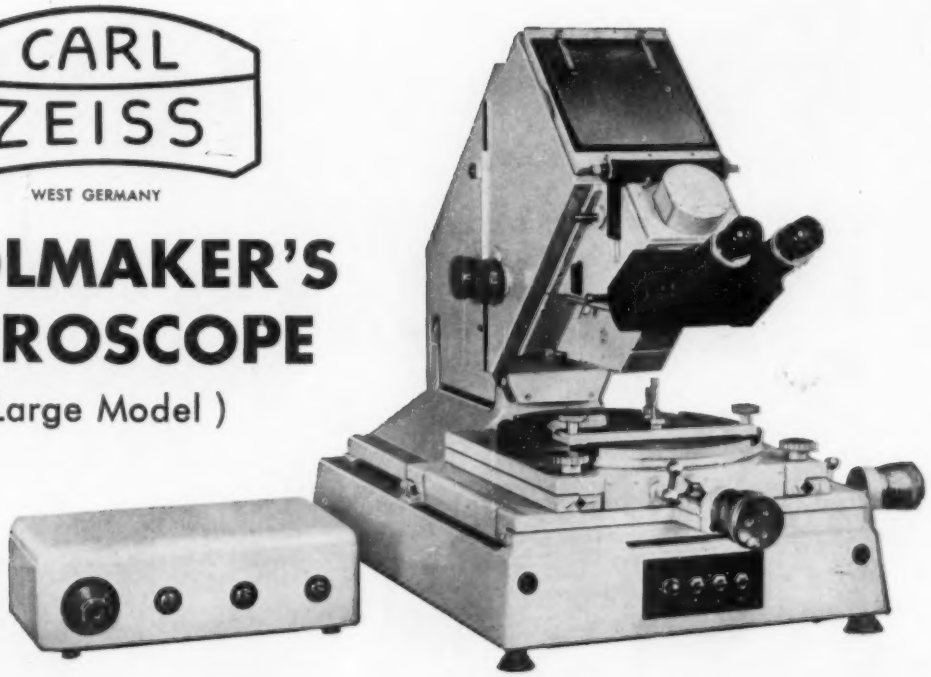
2082

CARL ZEISS

WEST GERMANY

TOOLMAKER'S MICROSCOPE

(Large Model)



A decided advance over former instruments

Measuring range of 3x6" permits extensive application

Small toolmaker's microscope also available.

This large toolmaker's microscope, made by Carl Zeiss, offers utmost ease, rapidity and great reliability of measurement.

Its new built-in gauge block displacement device makes it possible to quickly move the stage in the longitudinal direction in five steps, and in the transverse direction in two steps, thus eliminating the old fashioned method of interchanging gauge blocks. All manipulations, adjustments and readings are performed from the same position in front of the instrument.

The inclined binocular tube can be tilted and adjusted to suit the convenience of the operator. During tilting, the image in the eyepiece always remains in focus. The object to be tested is seen simultaneously with the cross-line of the protractor. The scale of the protractor and templet, however, can be projected consecutively into the eyepiece.

BUILT-IN BEAM-SPLITTING DEVICE

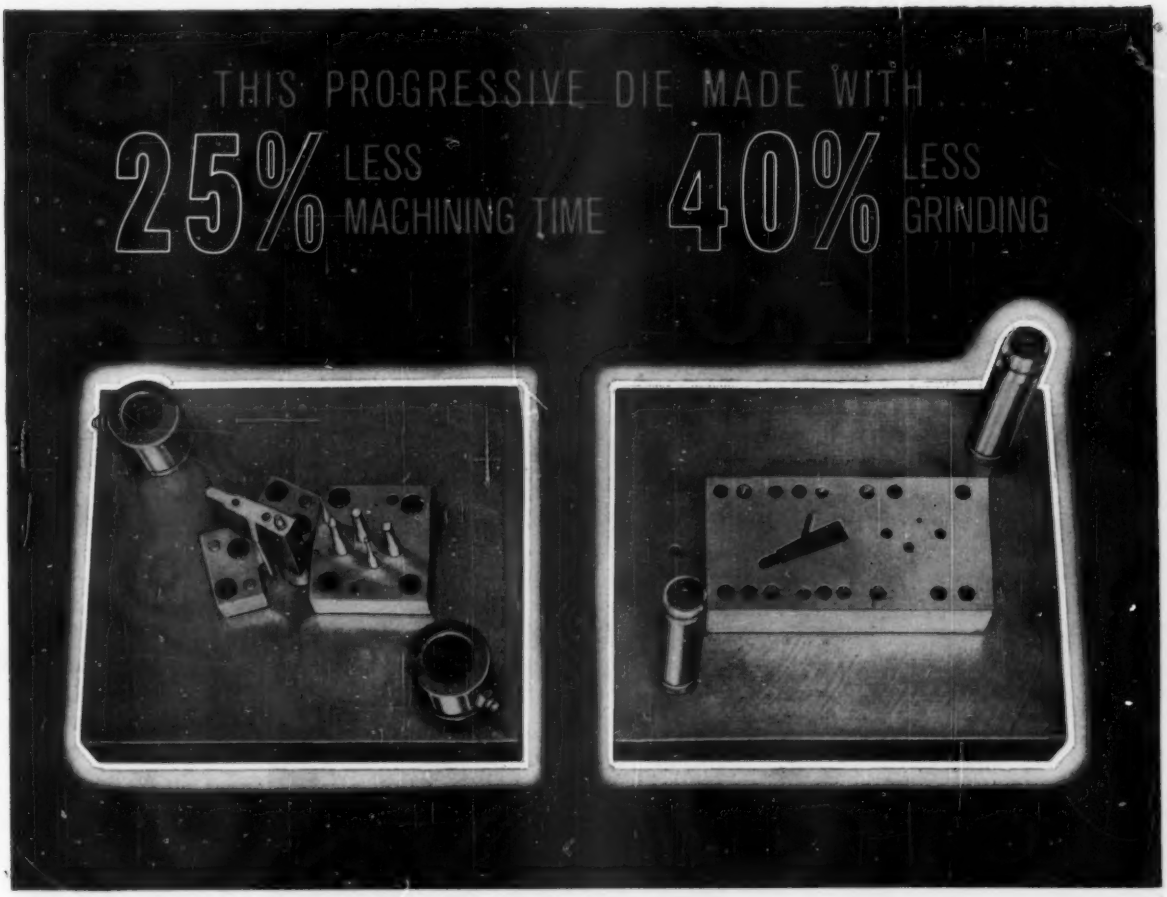
Another novel feature of this instrument is the new built-in beam-splitting device with single or double reversed image in complementary colors for line-symmetrical or center-symmetrical measurements.

Write for literature

CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17, N. Y.

COMPLETE SERVICE FACILITIES



LO-AIR TOOL and DIE STEEL

*Low Temperature · Air Hardening**

. . . CUTS PRODUCTION COSTS

Accurate Machine and Tool Company of Roselle Park, N.J., reports savings of 40% in grinding and 25% in machining time on this progressive die—through the use of LO-AIR, the tool and die steel that is easy to machine —has least distortion in hardening.

On oil hardening tool steels, previously used for this die, .015″ was allowed on sides for grinding and .005″ in jig bored holes before heat treating. With LO-AIR they found it safe to allow not more than .0025″ on sides and no extra in holes before hardening—making great savings possible.

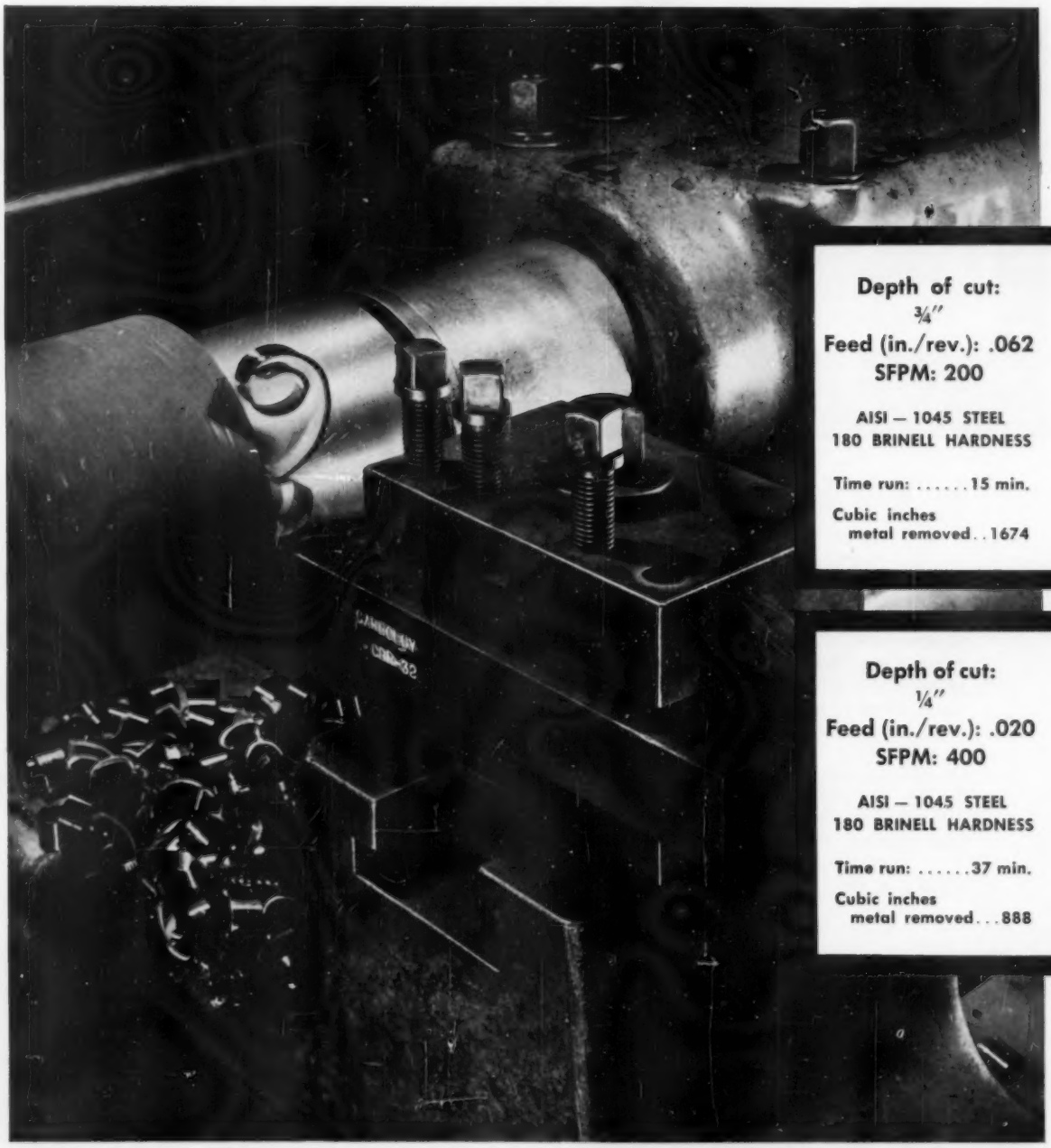
For complete information, write today for Performance Report No. 20. Also, we will gladly send you a copy of our 12-page LO-AIR brochure on applications, properties and other technical data. For immediate delivery of LO-AIR, call our nearest sales office or warehouse. Complete stocks available.

**U.S. Pat. No. 2,355,224*

UNIVERSAL CYCLOPS
STEEL CORPORATION
EXECUTIVE OFFICES: BRIDGEVILLE, PA.

TOOL STEELS • STAINLESS STEELS • HIGH TEMPERATURE METALS

Why ?



Depth of cut:
¾"
Feed (in./rev.): .062
SFPM: 200

AISI — 1045 STEEL
180 BRINELL HARDNESS

Time run: .....15 min.

Cubic inches
metal removed..1674

Depth of cut:
¼"
Feed (in./rev.): .020
SFPM: 400

AISI — 1045 STEEL
180 BRINELL HARDNESS

Time run: .....37 min.

Cubic inches
metal removed...888

Why is one Carboloy carbide grade best for light-duty steel-cutting applications; another more suitable for heavy-duty jobs? And which should you use?

Carbide selection can be scientific (and *should* be!) if you are going to get optimum results from your steel-cutting operation.

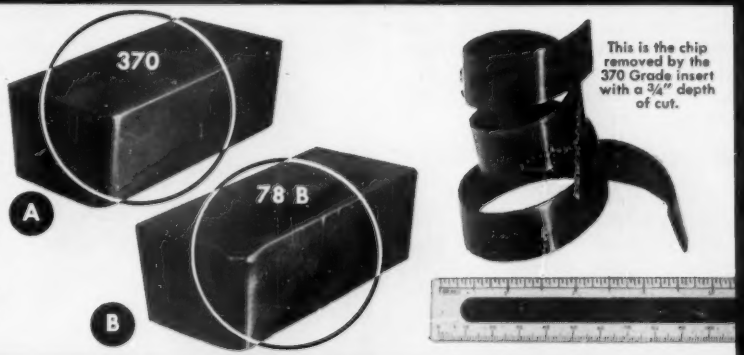
Take the job-graded Carboloy Grades 78B* and 370, for example. The 78B Grade is designed to offer real economy in normal steel-cutting applications—where machine power is limited. The 370 Grade, on the other hand, was developed specifically for heavy-duty steel-cutting jobs. Look over the following examples; then contact your Carboloy representative, or Authorized Carboloy Distributor, for information on Carboloy *job-graded* carbides for your specific operation. Take advantage of *better profits through better tooling.* Call today, or write: *Metallurgical Products Department of General Electric Company, 11101 E. 8 Mile Street, Detroit 32, Michigan.*

*Carbides in 78 Series are all pre-honed. Carbides in the 300 series are available pre-honed, precision-ground, or utility-ground.

HEAVY-DUTY MACHINING

Photograph A shows the Carboloy 370 Grade insert after the run. Wear land was only .012", and there is no deformation (upsetting) of the cutting edge. Photo B shows the 78B Grade insert after the same run. Note the deformation of the cutting edge . . . Grade 78B was not designed for such severe cutting pressures.

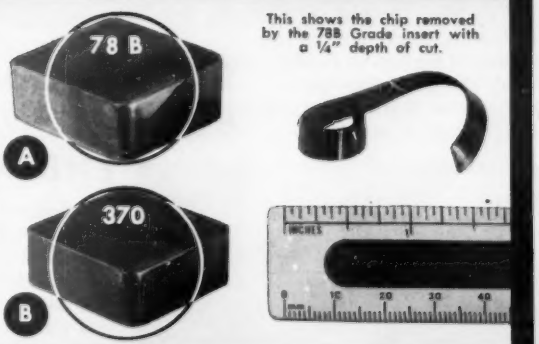
CONCLUSION: *In this heavy-duty application, Carboloy 370 Grade is recommended.*



LIGHT-DUTY MACHINING

In this light-roughing application there is little visible difference between the Carboloy 78B Grade insert (Photo A) and the 370 Grade insert (Photo B). Because 78B Grade is job-graded for light- and medium-roughing applications, it will wear as long as 370 Grade. Grade 78B insert is lower in initial cost, so in this case it makes good sense to use Grade 78B. In this example, the wear land on 78B insert was only .010".

CONCLUSION: *In this normal steel-cutting application, Carboloy 78B Grade is recommended.*



CARBOLOY CEMENTED CARBIDES

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

Atrax

Precision Ground
SOLID CARBIDE
TOOLS AND BURS

Job Applications

Solid carbide, 6 flute, ball nose, right hand spiral end mill .170" in diameter easily cuts rugged stainless steel alloy impeller buckets to close, uniform tolerances.

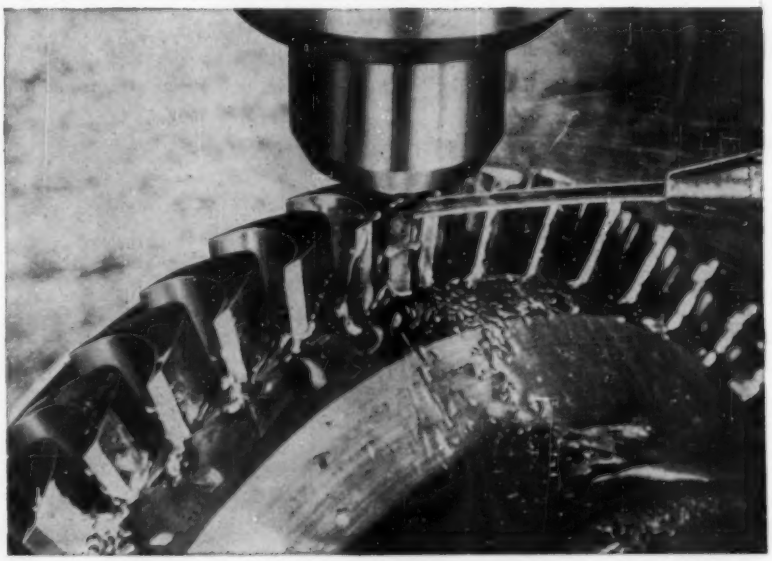
PRODUCTION UNIFORMITY

Milling cut was ½" deep. Work piece was held and rotated by means of a cam controlled fixture, the spindle and end mill were stationary. 42 buckets per impeller wheel had to be uniform in size, shape, weight and balance.

LONG TOOL LIFE ESSENTIAL

Because of the close tolerances required, end mills could not be resharpened so that maximum production without changing tool cutting characteristics was vital. Atrax end mills out-produced all others.

EXOTIC MATERIALS PROVE EFFICIENCY OF ATRAX SOLID CARBIDE END MILLS...



This Atrax end mill was produced as a special only to satisfy exacting tolerances on this extremely tough stainless steel alloy.

SIMILAR SUCCESS MILLING TITANIUM BUCKETS WITH 1/16" DIAMETER ATRAX END MILL!

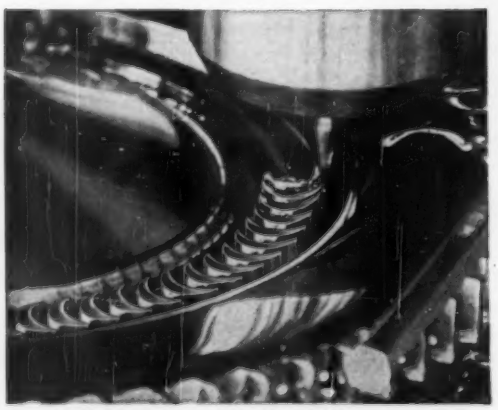
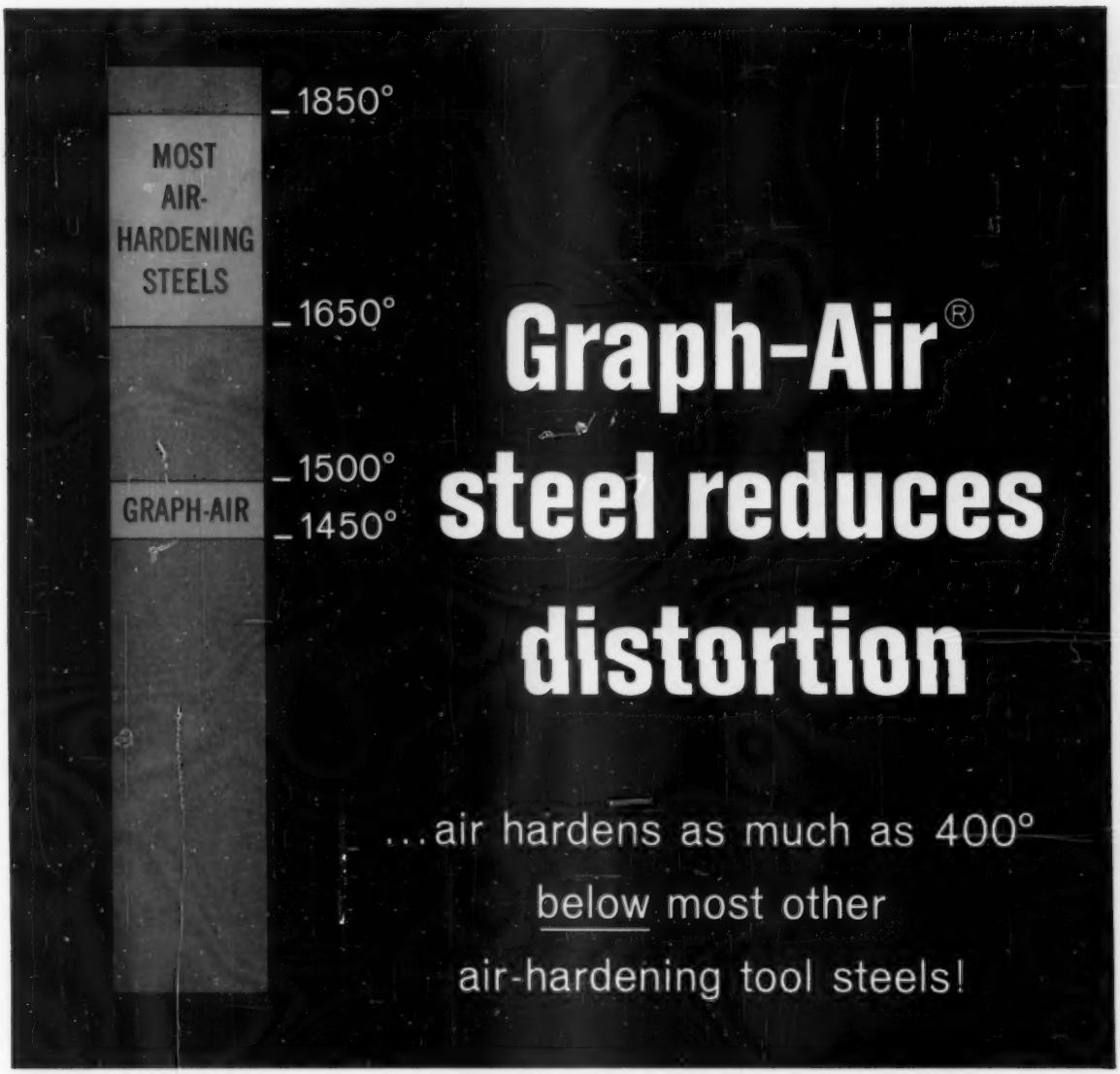


Photo shows a 1/16" diameter Atrax End Mill profiling to fine micro-finish buckets of a titanium turbine impeller. Each Atrax tool completed 72 buckets on each of 4 impeller wheels before replacement. The production performance proved far superior to high speed steel that deflected and broke under initial cut and competitive solid carbide end mill that produced profiling cuts on only 36 buckets before failure.

There's an Atrax Solid Carbide End Mill job engineered for virtually every end milling material and application.

Send for your copy of the 148 page Atrax Catalog.

THE ATRAX COMPANY
240 DAY STREET, NEWINGTON 11, CONN.



You can simplify heat controls and reduce distortion in your heat-treated parts. Graph-Air® hardens at 1450°F.—as much as 400° below temperatures required for other air-hardening tool steels. And these lower temperatures also cut scaling and decarburization.

Graph-Air machines easier too, because of the free graphite in its structure. And because it contains diamond hard carbides throughout, it lasts and lasts—as much as three times as long as other tool steels. What's more, with its built-in stability, Graph-Air holds its accuracy better. It's one of the family of Timken graphitic tool steels, the most stable made.

If you're making intricate sections, you'll appreciate the reduced distortion of Graph-Air. It's ideal for blanking dies that must take a lot of punishment.

When you buy Timken steel you get . . . 1) Quality that's uniform from heat to heat, bar to bar, order to order. 2) Service from the experts in specialty steels. 3) Over 40 years experience in solving tough steel problems.

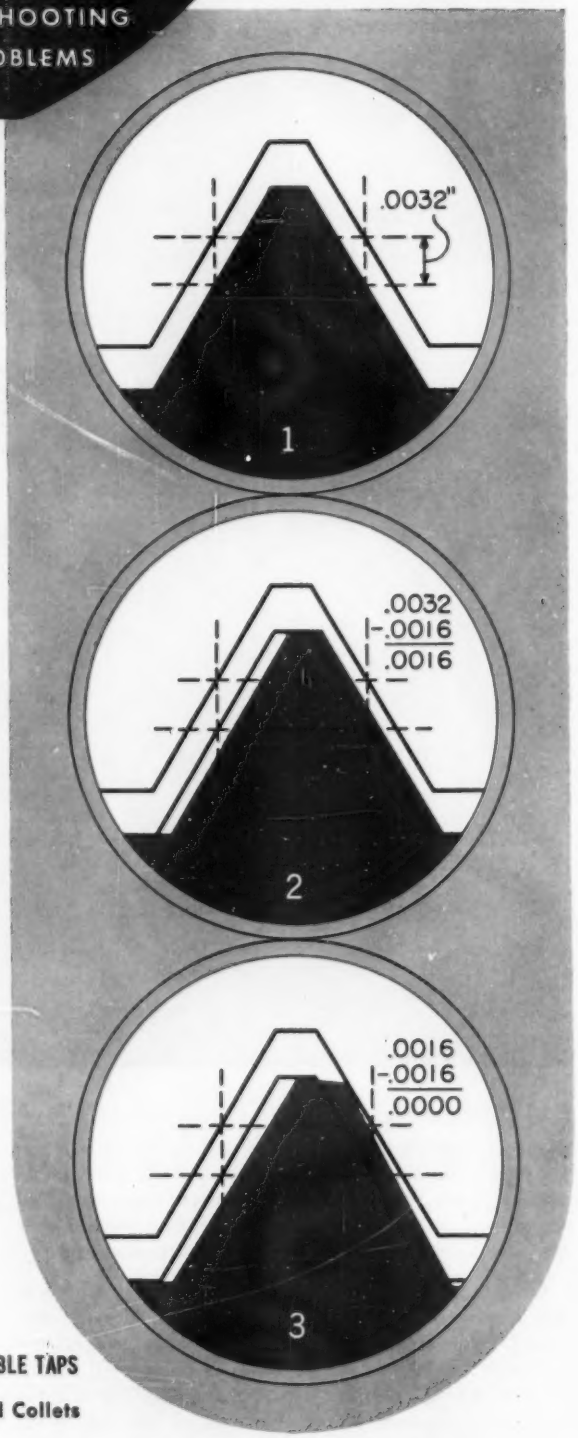
For high quality tool steel that air hardens at lowest temperature, be sure to specify Timken Graph-Air steel. Available in solid and hollow bar sizes. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
Fine Alloy **STEEL**

TIMKEN GRAPHITIC STEELS ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 40 CITIES IN THE UNITED STATES AND CANADA

TROUBLE-SHOOTING
THREADING PROBLEMS

lead error



WHAT IT COSTS

Lead error is bad enough by itself. But, when combined with other factors, it's worse. For instance, consider what happens to this 3/4-16 Class III thread.

Chart 1. shows a good thread which allows the full tolerance of .0032" on the pitch diameter for chaser wear. The same thread is shown in chart 2., but this time with a slight lead error of .0009" in 3/4 of an inch of thread length. *The working tolerance is now cut in half.* Chart 3. shows what happens when just a fifty-nine second (less than one degree) flank angle error is added to that small lead error. *There now is no working tolerance left.*

From this simple illustration, it is evident that the closer you can maintain lead and flank angle, the more size adjustment you have left for chaser wear. In other words, perfect lead and thread form present maximum provision *for better threads at lower cost.*

HOW TO PREVENT IT

Lead and thread form error are never a serious threat with J&L threading tools. Here's why:—

1.) The thread form is ground on the chaser after hardening, removing the possibility of heat-treating distortion.
2.) The thread form is ground on the exact helix angle for the diameter and pitch of thread to be cut.
3.) The non-cutting teeth on the chaser form a precision lead nut to lead on to the work.
4.) The die head has the rigidity and "beef" to hold the chasers in proper position in spite of cutting pressures.

OUR OFFER

We solve threading problems. May we tackle some of yours? Send them in—no obligation.

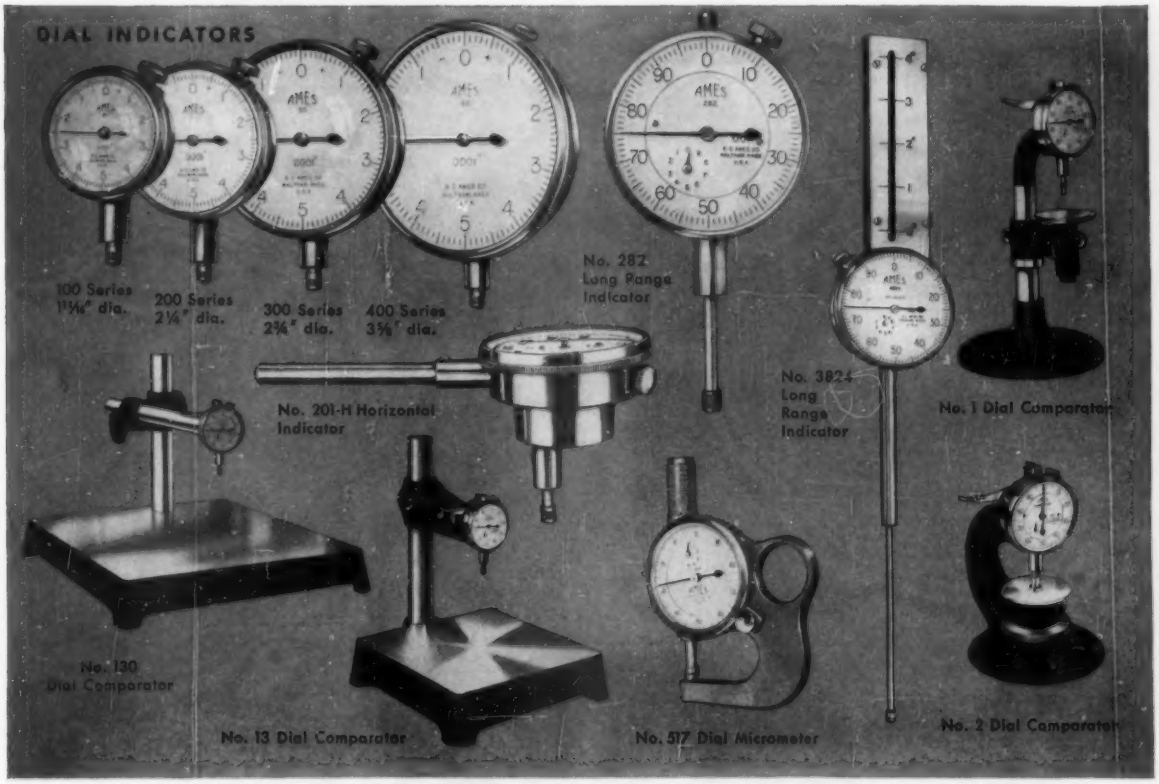
TANGENT & RADIAL DIE HEADS • COLLAPSIBLE & SOLID ADJUSTABLE TAPS
also
Self-opening Stud Setters • Modern-Magic Chucks and Collets
Precision Boring Machines

JONES & LAMSON

THREAD TOOL DIVISION

Jones & Lamson Machine Company, 518 Clinton Street, Springfield, Vt., U. S. A.

AMES *Masters of Measurement*


DIAL INDICATORS
100 Series 1 1/16" dia.
200 Series 2 1/4" dia.
300 Series 2 3/4" dia.
400 Series 3 5/8" dia.
No. 282 Long Range Indicator
No. 201-H Horizontal Indicator
No. 3824 Long Range Indicator
No. 1 Dial Comparator
No. 130 Dial Comparator
No. 13 Dial Comparator
No. 517 Dial Micrometer
No. 2 Dial Comparator

DIAL INDICATORS AND GAUGES

Use Them for Checking: taper, height, depth, flatness, roundness, straightness, thickness, diameter, length and size.

Features Include: easy-to-read dials, unbreakable crystals, forged cases, backs and wheel support, contour-lapped pinion teeth.

Attachments: rubber and metal dust guards, long stem indicators, tolerance hands, lift levers, special backs, contact points, etc.

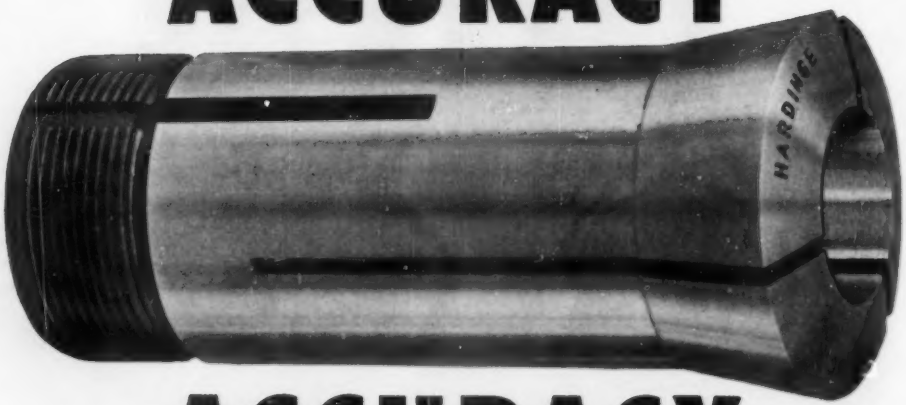
For literally hundreds of measuring, indicating and comparing operations, you'll find Ames standard and customized gauges and indicators unerringly accurate and amazingly durable . . . *You're asking for the best when you specify Ames!*
B. C. AMES CO., Waltham 54, Mass. Representatives in Principal Cities—
In Canada, H. C. Burton Co., 166 Rebecca Street, Hamilton, Canada.

B. C. AMES CO.

MANUFACTURERS OF MICROMETER DIAL INDICATORS, DIAL GAUGES, ACCU-FLOW AIR GAGES, PORTABLE TRANSISTORIZED COMPARATORS

HARDINGE
ELMIRA, N.Y.

ACCURACY
ACCURACY
ACCURACY
ACCURACY
ACCURACY



ACCURACY
ACCURACY
ACCURACY
ACCURACY
ACCURACY

***HARDINGE** has specialized in the manufacture of collets since 1890.*
***HARDINGE** today stocks collets in sixteen principal cities in the United States and Canada.*
Ask for descriptive bulletins.

HARDINGE BROTHERS, INC., ELMIRA, N. Y.
PERFORMANCE HAS ESTABLISHED LEADERSHIP FOR HARDINGE

Immediate stock delivery from Atlanta, Boston, Chicago, Dayton, Detroit, Elmira, Hartford, Los Angeles, New York, Philadelphia, Seattle, Portland, Minneapolis, Oakland, St. Louis, Springfield, N. J., and Toronto.

NORGREN SALES AND SERVICE REPRESENTATIVES

ATLANTA 11, GA.
Air & Hydraulics Eng., Inc.
Diamond 4-3433

BALTIMORE 18, MD.
N. B. Cochrane Co.
HOpkins 7-4884

BIRMINGHAM 5, ALA.
Air & Hydraulics Eng., Inc.
ALpine 2-6101

BUFFALO, N. Y.
Goll-Hanford Corp.
SPring 7200

CEDAR RAPIDS, IOWA
Walter Norris Eng. Co.
EMpire 3-0438

CHARLOTTE 7, N. C.
L. W. Kinnear & Co., Inc.
FRanklin 6-7553

CHICAGO 6, ILL.
Walter Norris Eng. Co.
STate 2-2804

CLEVELAND 7, OHIO
F & W Ursem Co.
LAkewood 1-9136

DALLAS 35, TEXAS
Leo. J. Schindler Co., Inc.
LAkeside 8-0517

DAYTON, OHIO
K. C. Mosier Co.
BA 4-9805

DENVER, COLO.
E. C. Wild Co., Inc.
SHerman 4-1253

DES MOINES, IOWA
Walter Norris Eng. Co.
ATlantic 2-8782

DETROIT 28, MICH.
William H. Nash Co., Inc.
BRoadway 3-7493

EVANSVILLE, IND.
Neff Engineering Co.
GReenleaf 7-4141

FLINT 2, MICH.
William H. Nash Co., Inc.
CEdar 5-0444

FT. LAUDERDALE, FLA.
Air & Hydraulics Eng., Inc.
LUdlow 3-5657

FORT WAYNE, IND.
Neff Engineering Co.
EAstbrook 7391 & 2

GRAND RAPIDS, MICH.
William H. Nash Co., Inc.
GL 2-0929

HARTFORD, CONN.
Pearse-Pearson Co., Inc.
Broomfield, Conn.
CHapel 2-7777

HONOLULU 13, HAWAII
Chapson Bros., Ltd.
57-306

HOUSTON 11, TEXAS
Leo J. Schindler Co., Inc.
WAlnut 3-2525

HUNTINGTON, W. VA.
K. C. Mosier Co.
JAckson 5-4831

INDIANAPOLIS 2, IND.
Neff Engineering Co.
WAlnut 5-5311

KANSAS CITY 15, KAN.
Air Equip. Co.
DRexel 1-3709

LOS ANGELES, CALIF.
The Teglen Eng. Co., Inc.
So. Pasadena, Calif.
MUrray 2-2856

LOUISVILLE, KY.
Charles Weber Co.
MElrose 7-2574

MILWAUKEE 8, WIS.
C. L. Thompson Co.
HIlltop 4-4817

MINNEAPOLIS 4, MINN.
H. U. Rogness
FEderal 3-5595

MOLINE, ILL.
Walter Norris Eng., Co.
764-1196

NEEDHAM, MASS.
Pearse-Pearson Co., Inc.
HIllcrest 4-1090

NEWARK, N. J.
K. E. Knotts Co.
Westfield, N. J.
ADams 2-8700

NEW YORK, N.Y.
K. E. Knotts Co.
BArclay 7-7455

OKLAHOMA CITY, OKLA.
Nix Supply Co.
ORange 7-6623

PHILADELPHIA, PA.
J. A. Moody Co.
Wayne, Pa.
MUrray 8-3750

PHOENIX, ARIZ.
Air-Draulics Co.
ALpine 8-6441

PITTSBURGH 26, PA.
Leonard R. Nourie, Inc.
LOcust 1-1628

PORTLAND 9, ORE.
Power Transmission Products
CA 7-1272

PROVIDENCE, R. I.
Pearse-Pearson Co., Inc.
GAspee 1-2557

RICHMOND 20, VA.
C. Arthur Weaver Co., Inc.
ELgin 9-5771

ROCHESTER 18, N. Y.
Goll-Hanford Corp.
GReenfield 3-8323

ROCKFORD, ILL.
Walter Norris Eng. Co.
WOodland 3-2811

SAN FRANCISCO, CALIF.
Airdraulic Ind. Products Co.
Burlingame, Calif.
DIamond 2-7297

SEATTLE 9, WASH.
George W. Warden Co.
ATwater 3-0622

SHREVEPORT, LA.
Harris Frederic & Co., Inc.
5-7455 & 5-7456

ST. LOUIS 10, MO.
Sturgis Equip. Co.
OLive 2-5380

STRATFORD, CONN.
Pearse-Pearson Co., Inc.
DRexel 8-2992

SYRACUSE 3, N. Y.
Ralph W. Earl Co.
GRanite 5-5145

TULSA, OKLA.
Nix Supply Co.
DIamond 3-8916

VANCOUVER, B. C.
Galbraith & Sulley, Ltd.
CHerry 5121

LACHINE-MONTREAL, QUE.
Cowper Co., Ltd.
MElrose 7-6746

TORONTO, ONT.
John Spotton Co., Ltd.
CLifford 9-8276

New Norgren Line of Compact Units

for processing compressed air

Filter-Regulator Combination Units

Type 73AB
⅛" pipe size.

Manual-Drain Compressed-Air Filter

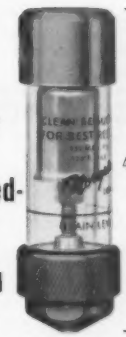
Model 30AJ-1—⅛" pipe size.

Pressure Regulators

Type 20AR—for air, water, oil and similar fluids—⅛" and ¼" pipe sizes.

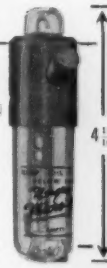
Diaphragm-Type Relief Valves

Type 40AB—for air, water, oil and similar fluids—¼" and ⅜" pipe sizes.



Automatic-Drain Compressed-Air Filter

Model 30BJ-1
⅛" pipe size.



Micro-Fog Lubricators

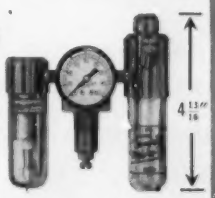
Model 10AG-1L—lubricates air-operated equipment and machine bearings.

Model 10AH-1L—lubricates air-operated equipment.

Both models ⅛" pipe size.

Micro-Fog Lubro-Control Units

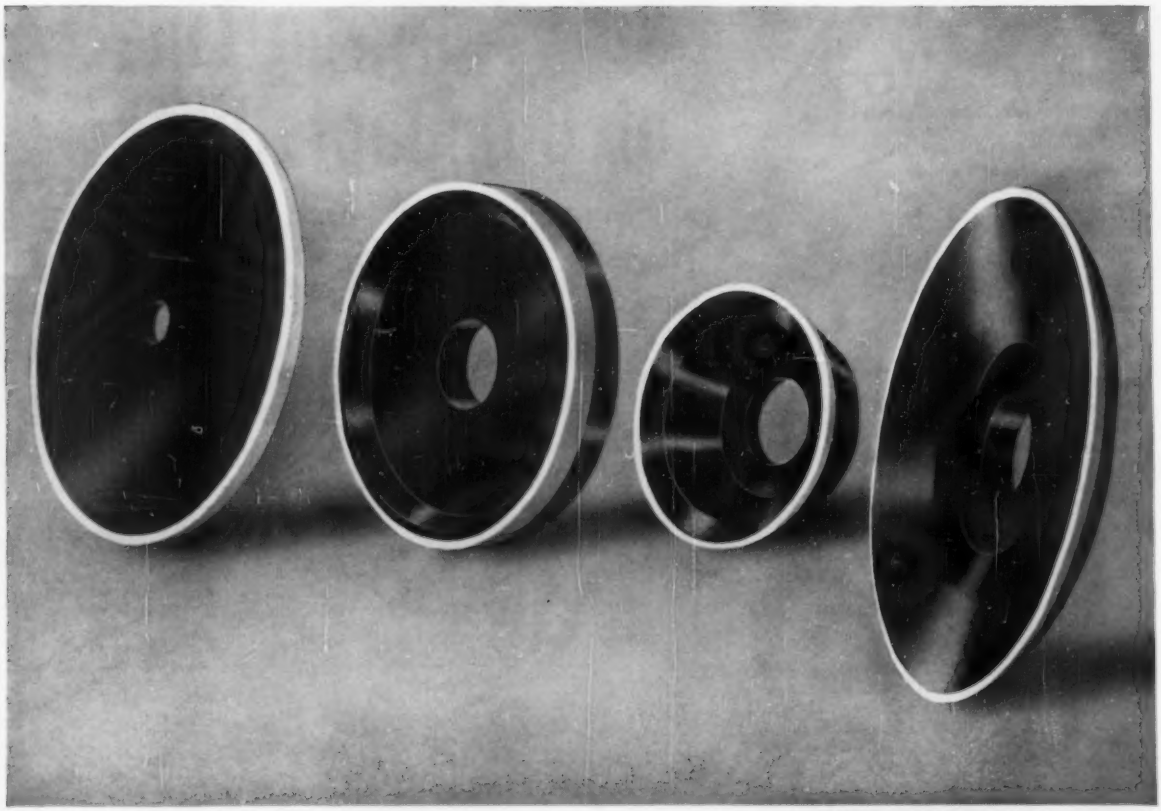
The new Norgren compact units may be used singly or in combination. Illustrated is a lubro-control unit made up of a 30AJ-1 filter, 20AR-1GG regulator and 10AH-1L lubricator—⅛" pipe size.



Norgren compact units give you big performance in small space. For complete information on the complete line of Norgren filters, regulators and lubricators in all sizes, call your nearby Norgren Distributor, listed at left—or write for brochure NA-3.

C. A. NORGREN CO. FOUNDED IN 1926

3447 SOUTH ELATI STREET • ENGLEWOOD, COLORADO



MANHATTAN DIAMOND WHEELS

Cut Cool and Free—Last Longer

Manhattan Diamond Wheels are engineered to give you faster, cooler cutting and longer life.

Advancements in Diamond Wheel construction and NEW RESINOID BOND developments fully utilize the advantages of both man-made and natural diamond insuring top performance from all Manhattan Diamond Wheels.

TRY Manhattan Diamond Wheels on your toughest application—find out for yourself how they perform in your plant—under your conditions—on your operation.

- New Bonds
- Longer Life
- Bonded for Specific Grinding Requirements
- Natural or Man-made Diamonds

"MORE USE PER DOLLAR"

RM1091

ENGINEERED RUBBER PRODUCTS ..."MORE USE PER DOLLAR"

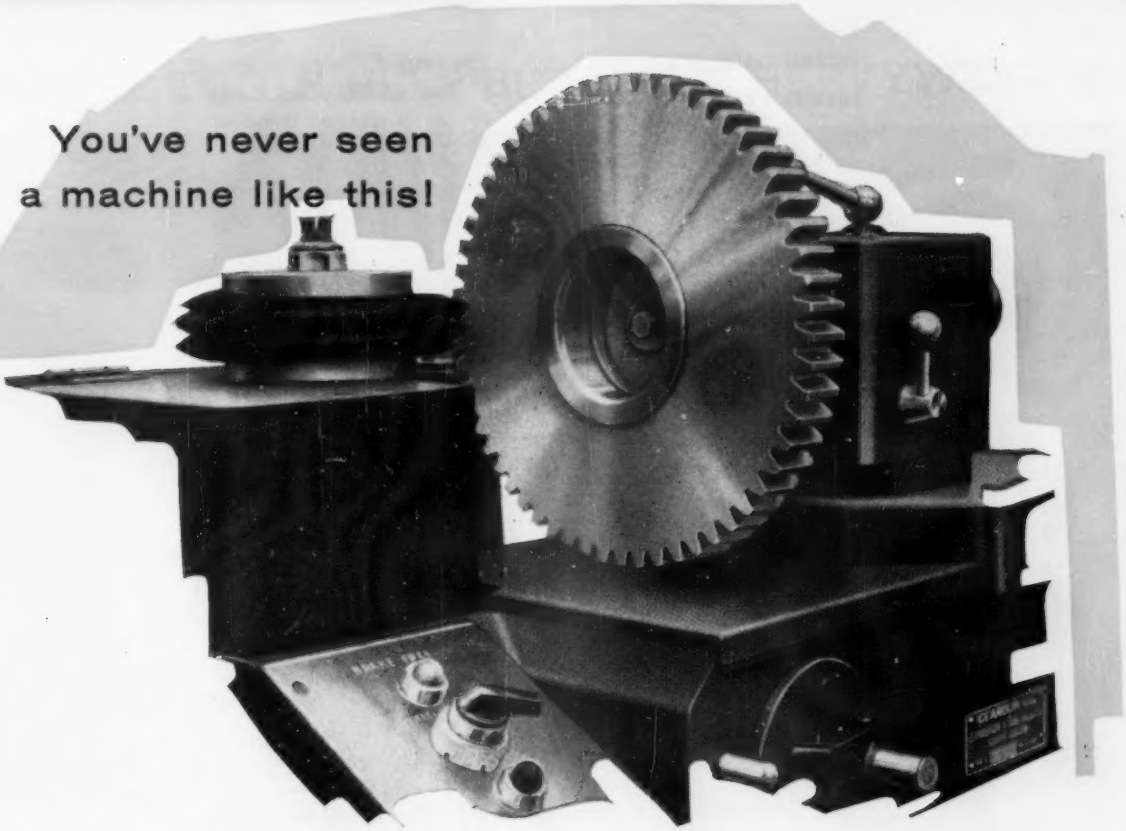
RM

WRITE TO DIAMOND WHEEL DEPARTMENT

MANHATTAN RUBBER DIVISION—PASSAIC, N.J.

RAYBESTOS-MANHATTAN, INC.

You've never seen
a machine like this!



LAPOINTE PARKINSON
Gearbur

removes the sharp edges and burrs from the sides of spur and helical gear teeth *more evenly than by hand — far more rapidly than by hand*

It's a chamfering method of de-burring.

Turns minutes into seconds, saving hours of hand work in removing burrs smoothly, correctly, quickly — even after hardening! One profiled grinding wheel will de-burr gears of different numbers of teeth of the same pitch and pressure angle, and will de-burr a large number of gears before requiring re-dressing. Capacity: Gears up to 11" dia. x 11" long with teeth 25 D.P. to 5 D.P.

Write for literature, to Department TE.

LAPOINTE MACHINE COMPANY
HUDSON, MASSACHUSETTS
Exclusive U. S. Agent for
ASSOCIATED BRITISH MACHINE TOOL MAKERS, LTD.

BUTLER Planers, Shapers, Slotters
CHURCHILL Grinding Machines
LANG Engine Lathes
PARKINSON Millers, Gear Shapers
WARD Turret Lathes

LAPOINTE
PRECISION MACHINE TOOLS

BY
AUTOMATICALLY
FORMING & WELDING

Eliminating multiple machine operations, and the high cost of parts handling and change-over

13 SIZES OF THESE
HEAVY-DUTY
HOSE CLAMPS

In a high-volume, high-precision process at Cuyahoga Products Corp., with a flexibility permitting rapid shifts from one part-run to another

PRODUCTION TIME
HAS BEEN
CUT IN HALF

Production has been increased 50%. Easy accessibility and maintainability of tools has reduced down time

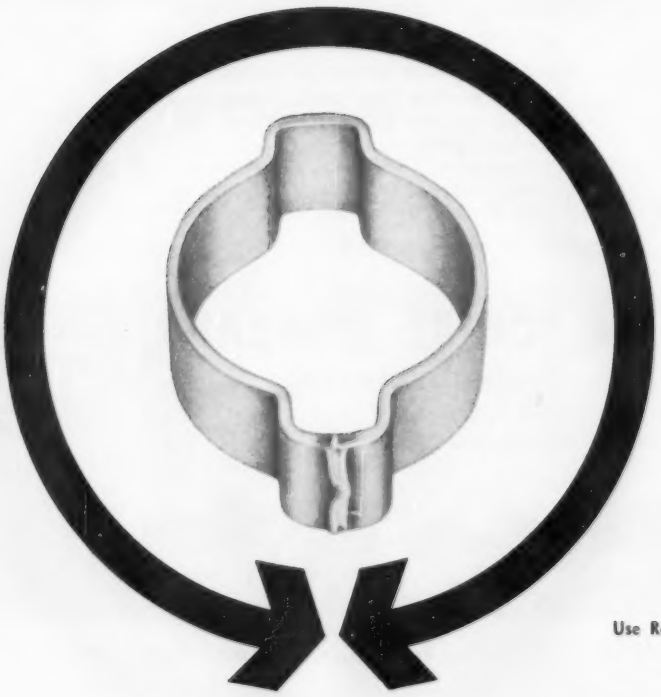
AND PROFITS
ARE BEING
MULTIPLIED

With no strain, and with the sweet click, click, click of profits

WITH THE VERSATILE
NEW TORRINGTON V-82
VERTICAL 4-SLIDE

Secondary operations such as the Cuyahoga hose clamp welding can only be done with such high production on a vertical 4-slide. For the complete story of this new production machine, write —

THE TORRINGTON MANUFACTURING COMPANY
MACHINE DIVISION • Torrington, Connecticut



Use Reader Service Card, CIRCLE 110

MORSE TOOLS HELP BUILD THE HEAVYWEIGHTS

Long-lasting, quality Morse Tools give Hough smoother holes . . . increased production . . . lower maintenance

Dependability, improved performance . . . these are the outstanding features of The Frank G. Hough Co.'s Payloader, Paymover and Paylogger tractors.

It's small wonder they turn to Morse for cutting tools to help build these quality products. Morse Cutting Tools are known throughout industry for their lastability . . . their quality . . . their capacity to machine faster, smoother, more accurately.

Let Morse help you with your cutting tool problems. Call your Morse Franchised Distributor today. He's the man with the answers.

MORSE

means "THE MOST" in Cutting Tools

MORSE TWIST DRILL & MACHINE CO., NEW BEDFORD, MASSACHUSETTS

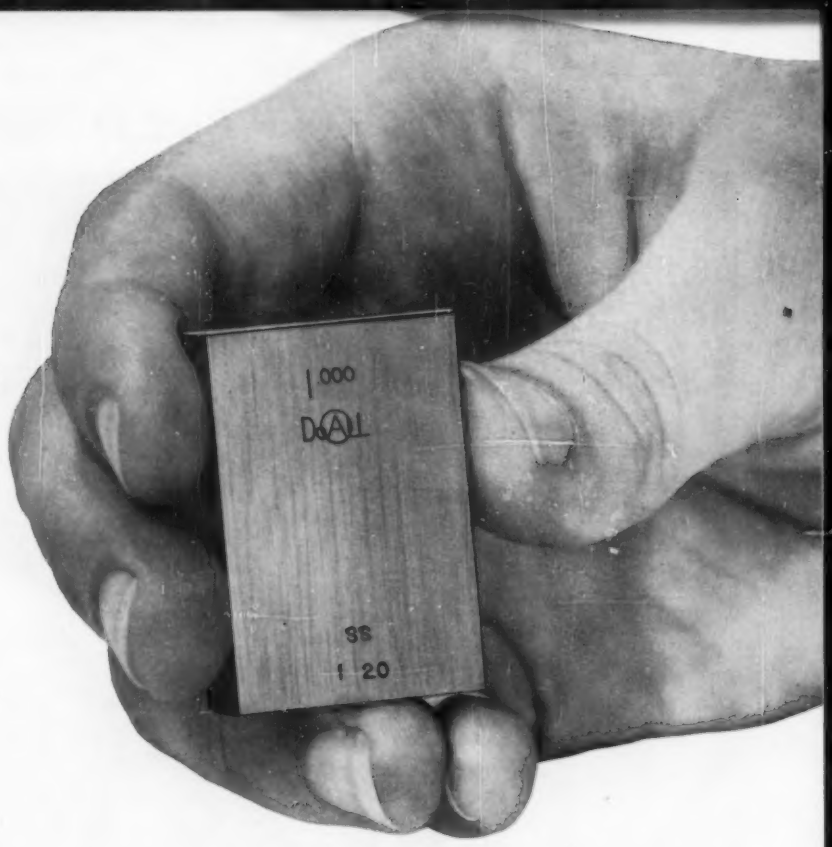
Warehouses in: NEW YORK • CHICAGO • DETROIT • DALLAS • SAN FRANCISCO

Morse means more production . . . smoother, more accurate production . . . with every type of cutting tool from drills, reamers, taps and dies, to end mills, milling cutters, slitting saws and "specials". So, if you want the best from every cutting tool you buy, mark your order "MORSE". For if you want *Morse Quality*, there's only one way to get it . . . *specify Morse.*

VN

A Division of VAN NORMAN INDUSTRIES, INC.

DoALL tells how Lindberg equipment helps produce stainless steel gage blocks



For the DoALL Company, Des Plaines, Illinois, heat treatment of their Stainless Steel Gage Blocks was a most formidable problem. For lasting accuracy these blocks require extremely hard, wear-resistant surfaces, free from growth or shrinkage, as provided by nitrided stainless steel. Case depth must be controlled accurately and the core maintained at full toughness free of stresses. DoALL found the answer to this problem with a Lindberg Gas Fired Vertical Cyclone Tempering Furnace with a Nitriding Retort.

DoALL

Norman Silver, Chief Metallurgist, and Lindberg Vertical Tempering Furnace at DoALL Company.

NORMAN SILVER, Chief Metallurgist says, "Our Lindberg equipment supplies the uniformity of heat distribution and the fast accurate control that is needed for the exacting requirements of our product. The furnace responds to control almost instantaneously and maintains the temperature within plus or minus 5°. Its 38" diameter by 36" depth handles 200 to 300 pound loads for the desired production. Results obtained have satisfied us completely with this, the latest of our Lindberg furnaces".

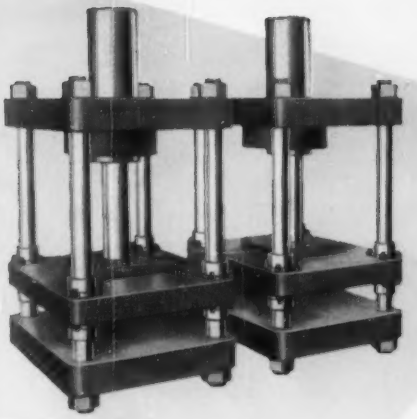
Lindberg provides the most complete line of heat treating furnaces, fuel fired or electric, large or small, for every heat treatjng requirement. Your Lindberg Field Representative (see your local classified directory) will be glad to consult with you on your heat treating requirements or write us direct. Heat Treating Furnace Division, Lindberg Engineering Company, 2447 West Hubbard Street, Chicago 12, Illinois.

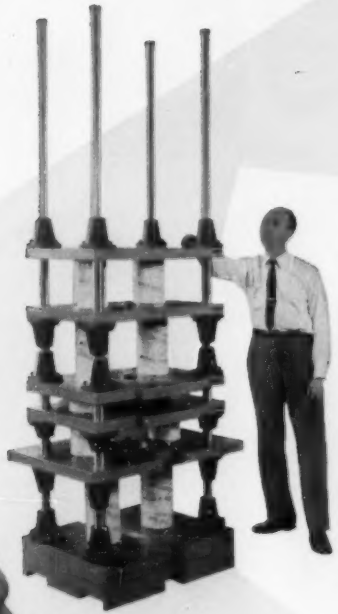
Los Angeles plant: 11937 S. Regentview Avenue, Downey, California. In Canada: Birlefco-Lindberg Ltd., 15 Pelham Ave., Toronto 9, Ont. Also, Lindberg plants in Argentina, Australia, England, France, Italy, Japan, South Africa, Spain, Switzerland and West Germany.

LINDBERG heat for industry

Use Reader Service Card, CIRCLE 112

Do you have a special die set problem?

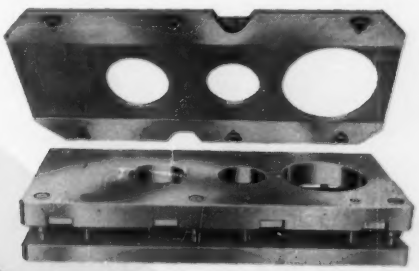




Producto can help you solve it. Special die sets can be large or small—weigh tons or a few pounds; they may be of steel plate, or castings; two-plate or multi-plate.

Often, they can be ordered directly from Producto's catalog. We regularly machine our "catalog specials" to meet your individual requirements. And, when you need a radically different, one-of-a-kind die set—call us. Our 35 years of die set manufacturing experience are yours for the asking.

Just call your nearby Producto distributor, or our manufacturing plants in Bridgeport or Detroit.



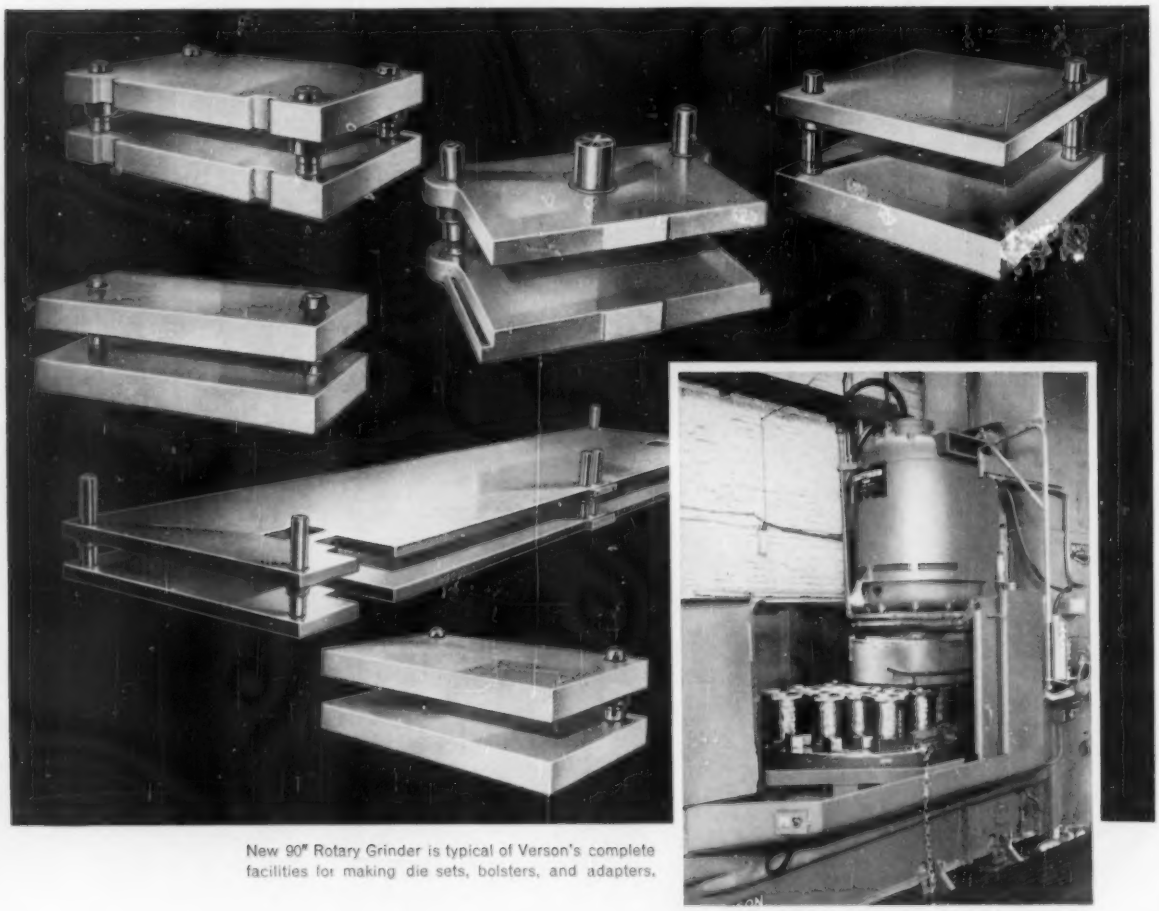
PRODUCTO

DIE SET DIVISION
THE PRODUCTO MACHINE COMPANY
925 Housatonic Avenue, Bridgeport 1, Connecticut

PRODUCTO

DIE SETS & ACCESSORIES • PUNCHES & DIES • TOOLROOM EQUIPMENT

MAKE VERSON YOUR SOURCE FOR DIE SETS



New 90" Rotary Grinder is typical of Verson's complete facilities for making die sets, bolsters, and adapters.

Complete fabricating facilities make VERSON DIE SETS more economical, more profitable for you

Now you can take full advantage of Verson's experience and unmatched fabricating and machining facilities the next time you invest in die sets.

Combine the real economy of precise tooling with your longest production runs. Verson's complete stock of roll steel can provide die sets of any size, shape or special machining. You get what you need when you get Verson Die Sets and Bolsters.

245

Verson

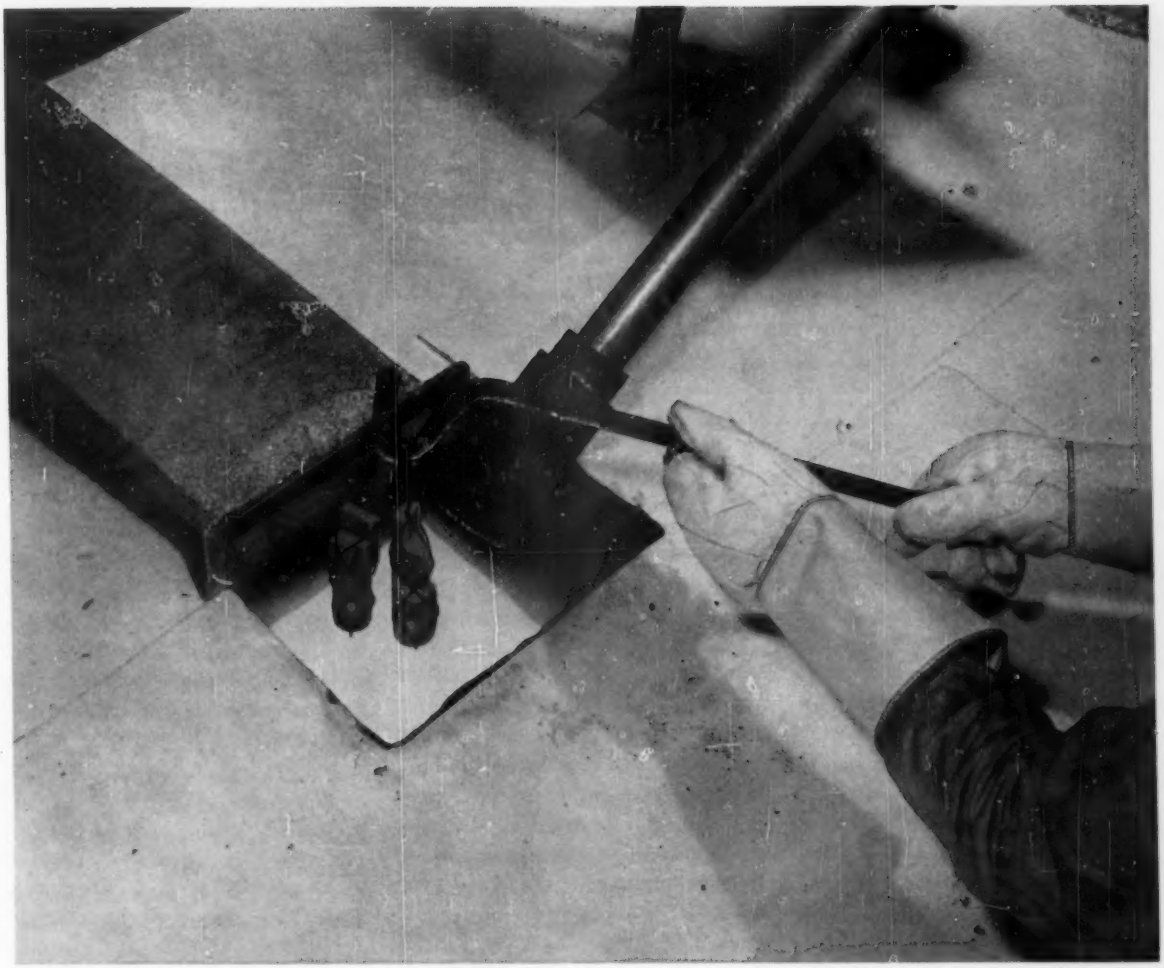
Originators and pioneers of allsteel stamping press construction

VERSON ALLSTEEL PRESS CO.

9336 S. Kenwood Avenue, Chicago 19, Illinois • 8300 S. Central Expressway, Dallas, Texas

MANUFACTURERS OF MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES

TRANSMAT PRESSES • IMPACT MACHINING PRESSES • TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES • HYDRAULIC SHEARS



WE TURN THE HEAT ON AT RICHARD BROTHERS

to take the heat off you. Punches might look alike—but quality can't always be seen.

Take Richard Brothers advanced heat-treating process, for example. Our electric salt-bath furnace is tailored specifically to the treating of punches and die buttons, which allows us to maintain more rigid specifications. Result? Our punches are tougher, have a higher resistance to impact, will wear longer, and perform more consistently. You can promise your customers the highest quality work . . . *delivered on time.* Next time, be sure to specify Richard Brothers punches, dies and related tools for all your metal-piercing needs. It pays to do business with the leader.

RELIABILITY

QUALITY

INTERCHANGEABILITY

COMPLETE STOCK

RICHARD BROTHERS PUNCH DIVISION

ALLIED PRODUCTS CORPORATION
26500 CAPITOL AVENUE • DETROIT 39, MICHIGAN

Why every metalworking plant should own a Barber-Colman numerically controlled lathe

This 16-inch swing lathe combines greatly simplified numerical control . . . low cost . . . and versatility to fit any shop that has short-run jobs, either step or taper turning. It is a completely flexible general-purpose machine—designed for rapid change-over and economical job-shop operation.

The Tape-r-guide, as you can see it at bottom of page, is one complete package. There is no freestanding console. The reader is in the headstock, and all other controls are in the rear panel.

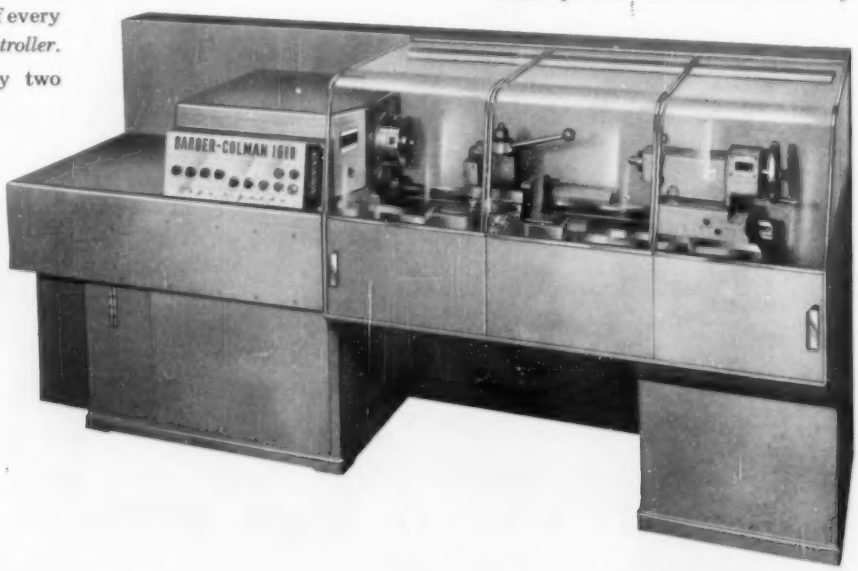
Here is a dramatically different approach to numerical control . . . one that operates without intricate memory units . . . one that is simple enough to gladden the heart of every maintenance man *and comptroller*.

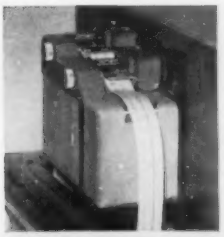
For example, there are only two thyratron tubes in the Tape-r-guide, and these are of a long-life, extra-duty type, guaranteed for two years. Except for these, and some common solenoids and relays, controls consist entirely of solid-state circuits. On-off devices have been used wherever possible. There is no quantitative requirement on electrical functions. There is no critical voltage level that would permit an off-size dimension and a scrapped piecepart. Basically mechanical actuation means you have a lathe that is easy to live with, has more time to cut metal.

Despite its extreme simplicity, Barber-Colman Tape-r-guide provides every one of the operating, control, and setup advantages you normally expect from the more complex tape-control systems. That's because it is designed specifically for its application and is incorporated right into the lathe. Handwheels and manual control levers are used for setup only.

Both axes always under direct control

All stop-start, positioning, speed adjustment, and feed change functions are controlled automatically from eight-channel binary code tape. Simple radii may be formed under tape control, using standard single-point tools. Both axes are continuously under precise and *direct* control. By





It pays for itself quickly on short-run step and taper turning jobs. You cannot buy the same capabilities in other lathes for anywhere near the price. And it's the simplest numerically controlled lathe to program, set up, operate, and maintain.

feeding both carriage and cross slide, the machine will cut accurate, discrete tapers having included angles from 2° to 172°. There is no feedback.

This machine will do your jobs faster than a tracer lathe because it relieves the operator more completely of size control, machine speed, operating, and setup responsibilities. Setup is faster and foolproof. Tools are preset off the machine for fast changing.

Now, you can eliminate the cost and inflexibility of templates and special tooling. Job programing and tape punching can be done for a small fraction of the cost of making templates. In short, the Tape-r-guide gives you more control and greater production than a tracer lathe—yet amazing simplicity takes it out of the price class of most numerically controlled machine tools.

System resolution is within ± .001" on diameter and length, but the machine itself is mechanically capable of even finer work. You can turn chamfers without special tools—perform cutoff, boring, drilling, and reaming operations, as well as internal and external step-turning. Antifriction ball screws and nuts increase sensitivity of the carriage and cross slide—you get fast, accurate response to every command.

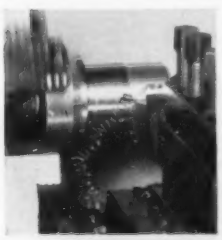
Even the coding is simple

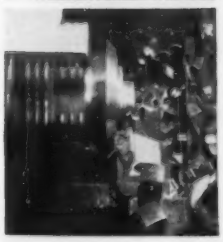
The Barber-Colman coding system is simple, which saves time in data processing. It is based on the binary system of numbers, designed expressly for engine lathe operations. There are only five alpha-type designations for the commands. Just one row on the tape completes an axis command . . . only a few rows are required for each complete command sequence.

Numerical control begins at the first point of operation of the tool, rather than from an absolute zero point. After reading the command, the machine executes instantly. Elimination of intermediate data storage reduces equipment cost and permits more efficient lathe design.

The Tape-r-guide produces fine finishes and precision tolerances—fast. It has large swing capacities (16" and 20"), infinite selection of spindle speeds to 1200 rpm, rapid traverse of the cross slide and carriage, and rugged frame castings made of dense Meehanite metal.

Ask your Barber-Colman representative for details on the "universal tooling" economics of Tape-r-guide numerical control.





Barber-Colman Company

BARBER COLMAN

123 Loomis Street, Rockford Illinois

DEPENDABLE... predictable response to heat treatment every time

Send for Bulletin 102— "Helpful Heat-Treating Hints."

The full uniformity within each bar of Desegatized FM die steel and the consistent uniformity from lot to lot simplifies the heat treatment of your die components. Predictable hardnesses are readily attainable . . . distortion and size change are minimized . . . danger of cracking is lessened!

In free machining FM die steels, full uniformity is achieved through Latrobe's unique Desegatized process of manufacture. This process guarantees an even distribution of carbide particles, free machining alloy sulphides and other alloying elements . . . factors leading to improved machinability, greater toughness and improved wear resistance in addition to the optimum heat-treating characteristics.

Latrobe's 12% chromium FM die steels are available through district steel service centers near you. Grades include: Olympic FM (Type D-2) for long-run applications; GSN FM (Type D-3) non-deforming die steel; Cobalt Chrome FM (Type D-5) for extra resistance to galling and pickup.

Call your Latrobe representative today!

Manufactured by skilled American labor

LATROBE
Metalmasters

LATROBE STEEL COMPANY
LATROBE, PENNSYLVANIA

BRANCH OFFICES and STEEL SERVICE CENTERS: BOSTON • BUFFALO • CHICAGO CLEVELAND • DAYTON • DETROIT • HARTFORD • LOS ANGELES • MIAMI • MILWAUKEE NEW YORK • PHILADELPHIA • PITTSBURGH • SAN LEANDRO • TOLEDO

Use Reader Service Card, CIRCLE 118

Use Reader Service Card, CIRCLE 119

MOTOR DRIVE HOUSING

THREE VERTICAL UNITS

1V COMBINATION FINISH FACE
TURN 2.75 DIAM.
ROUGH REAM .516

3V FINISH REAM FOR BUSHING

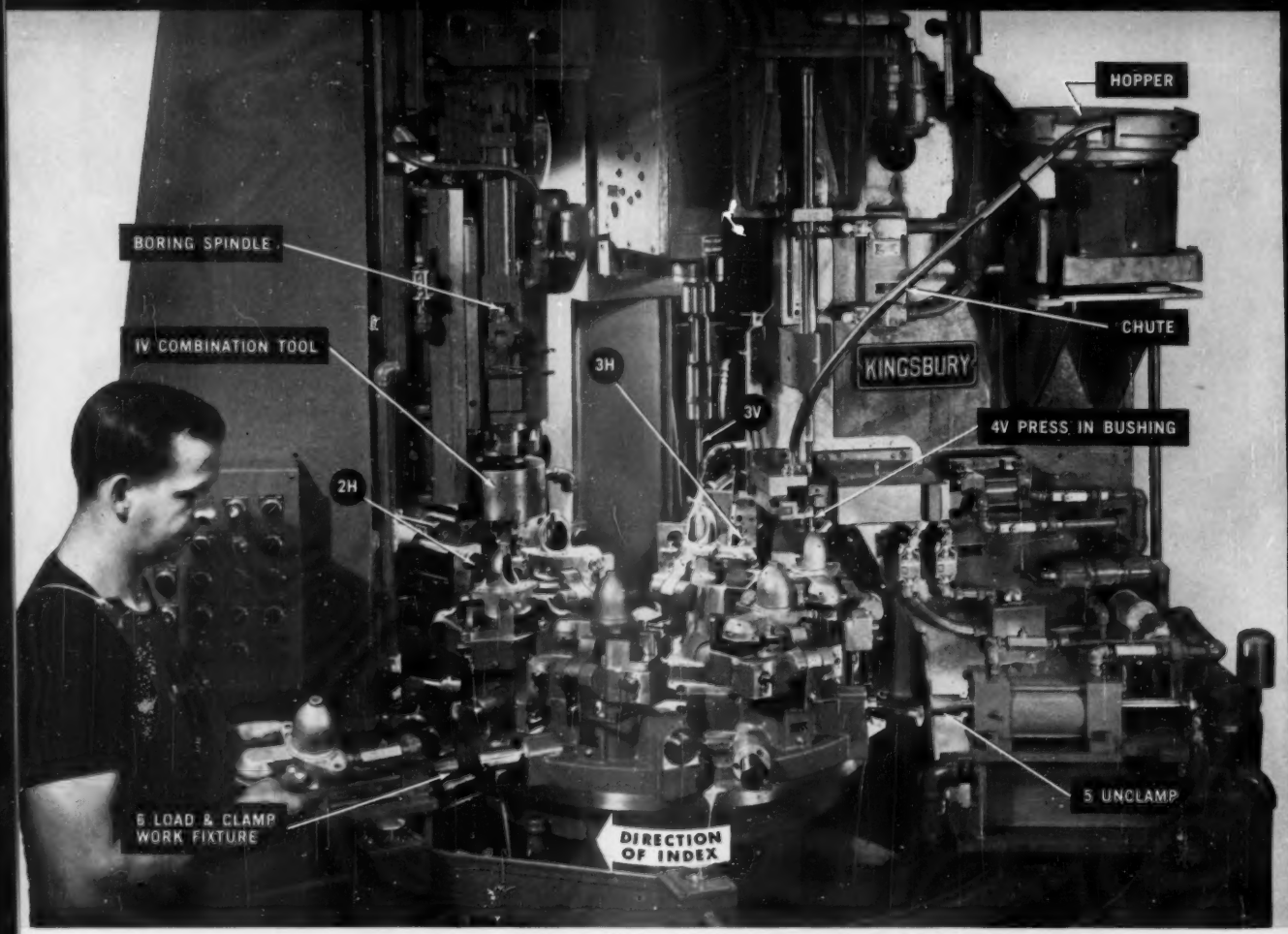
4V PRESS IN BUSHING
BURNISH BUSHING I.D.

500 PARTS PER HOUR GROSS

TWO HORIZONTAL UNITS

2H DRILL

3H LINE REAM
THRU 2 WALLS



How versatile can a Kingsbury machine be?

This indexing automatic drills, reams, turns, faces — even presses and burnishes

Check the drawing against the photo and you'll see it's possible to combine a variety of operations in one Kingsbury. You get high production and you *don't* sacrifice accuracy.

How did we combine so many operations in a 26-inch four spindle machine with only six work fixtures?

First, a special boring spindle with a large combination tool turns, finishes and faces. Slides instead of guide rods provide the rigid mounting needed for large tools working to close tolerances.

Second, the return stroke of the pin that presses in the bushing also burnishes the bushing's inside diameter.

Third, good basic design and rugged accurate construction result in the most efficient, compact setup for the job.

If you even *suspect* a Kingsbury might fit into your production, why not ask us? If we say we can do it, we can do it. Test runs before shipment guarantee each Kingsbury will produce uniform parts that gage. Kingsbury Machine Tool Corp., Keene, N. H.

KINGSBURY MULTI-UNIT AUTOMATICS

1185 DOLLARS BUYS THIS CLAUSING 1-1/16" Collet Capacity Lathe

and look what you get

- **VERIFIED ACCURACY**—guaranteed by 16 precision tests documented for you in report accompanying each lathe.
- **FLAME HARDENED BED WAYS**—"accuracy protection" which costs many dollars more on other lathes.
- **BIG FORGED SPINDLE**—1⅜" bore, 1 1/16" collet capacity.
- **"ZERO PRECISION" TIMKEN SPINDLE BEARINGS.**
- **SHAVED GEARS**—another CLAUSING "exclusive" assuring greater accuracy and smoothness.
- **BIG CAPACITY**—No. 5418 (illustrated) has 12¾" swing, 23" between centers, 10-speed ball bearing countershaft. Takes up to 1½ HP motor, extra. *Also available with 35" and 48½" centers, and with variable speed drive, clutch and brake, L-00 spindle.*

These, and other features—plus low initial investment—make the Clausing the greatest value in lathe history! Write today for full information.

350

CLAUSING
DIVISION OF
ATLAS PRESS COMPANY

OUTSTANDING VALUES IN PRECISION MACHINES

12-117 N. PITCHER STREET, KALAMAZOO, MICHIGAN

ANOTHER NORTON PRODUCT

It will pay YOU

...to use resin-bonded belts

HERE are the simple facts of the matter: Behr-Manning resin-bonded abrasive belts are faster cutting. Loading or shedding is at a minimum. Naturally, therefore, they last longer than glue-bond belts, and completely justify their slightly higher initial price by the production savings you enjoy.

There are two principal types of Behr-Manning resin-bonded abrasive belts:

RESINALL® . . . an all resin-bonded aggressive belt of strong X-weight cloth, for maximum heat resistance in most all rough and intermediate grinding operations.

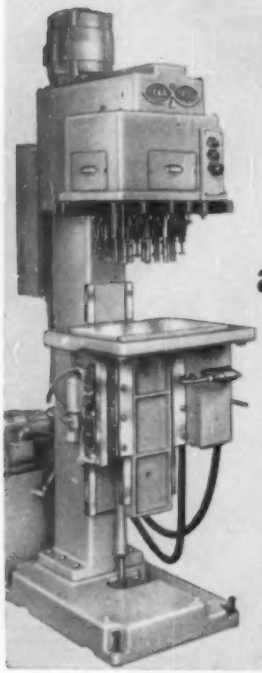
RESINIZED® . . . a resin-over-glue belt of good heat resistance, in strong X-weight for flat polishing, and in flexible J-weight for contour polishing.

Prove to your own satisfaction how resin-bonded belts will save you time and money. Ask for an in-plant demonstration. Write Dept. TE-12, BEHR-MANNING CO., Troy, N. Y., a division of Norton Company.

BEAR BRAND Abrasives

Use Reader Service Card, CIRCLE 121

DEKA DRILL



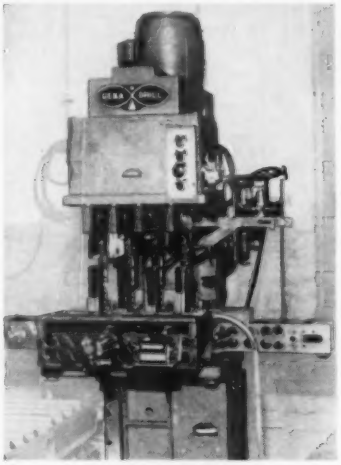
HYDRAULIC MULTIPLE SPINDLE DRILLING and TAPPING MACHINE

Send us one of your drilling or tapping problems for a free time study estimate. Find out how automatic cycle drilling and tapping with DEKA-DRILL can increase production and save time and money for you!

DEKA-DRILL CHAMFERS VARYING SIZED PARTS TO UNIFORM DEPTH!

COMPANY: Herschel Mfg. Co., Peoria, Illinois

A DEKA DRILL CASE HISTORY



OPERATION: Countersinking holes to uniform depth for subsequent riveting operation.

PRODUCTION: 2500 pieces per hour.

TECHNIQUE: Deka-Drill is fitted with adjustable dwell control to hold table at depth of stroke for ½ second. An air operated rack and shuttle feed inserts four pieces SAE 1095 25-30 Rockwell "C" into fixture simultaneously. A .228 hole, .100 deep at 60° including angle to .320 width is countersunk at 325 RPM. Machined pieces are automatically ejected by air onto conveyor.

PRECISION TOOL AND MFG. CO. of ILLINOIS

DEPT. TE-120 1305 S. LARAMIE AVENUE, CICERO 50, ILLINOIS

Use Reader Service Card, CIRCLE 122

GREAT NAMES IN INDUSTRY produce MORE for LESS with PEECO

The story at PEECO can best be paraphrased — "... known by the company they keep . . ." The long list of companies that now 'produce more', because PEECO vibratory feeders are engineered to work, reads like America's industrial "Who's Who". PEECO'S technical knowledge in parts feeding can help you schedule one or more parts at a given rendezvous at a predetermined rate per hour and oriented to the exact position desired. Obviously this generates great savings. Let PEECO sales engineers help you 'produce more'. Send for new literature on the latest feeding technique.

PEECO FEEDS THEM ALL

VFC and PEECO are DIVISIONS of AUTOMATION DEVICES, INC.

TWO GREAT NAMES IN PARTS FEEDING

AUTOMATION DEVICES INC.

32nd and BRANDES STS., ERIE, PA. • PH. GL 6-5381

Use Reader Service Card, CIRCLE 123

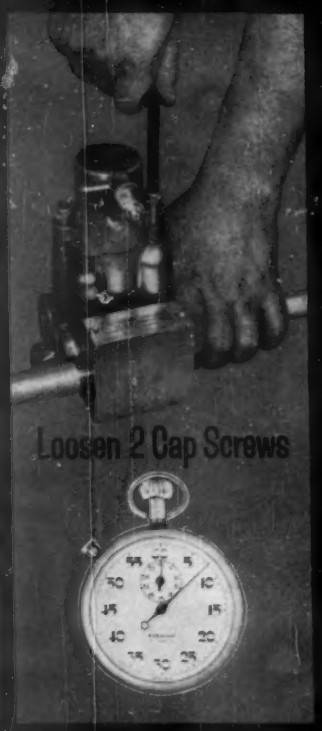
Use Reader Service Card, CIRCLE 125

ONE MAN ONE TRADE ONE TOOL

...your production line back in operation in

30 SECONDS

(if it's a Hunt PDQ Air Control Valve)



☑ accessibility ☑ simplicity ☑ speed and capacity ☑ price and quality

No bulletin can do it justice... have the Hunt man call. Write to:

HUNT VALVE COMPANY DIVISION OF IBEC SALEM, OHIO

HUNT V H C *Quick-As-Wink* AIR & HYDRAULIC CONTROL VALVES

Unique new use of special

In manufacturing, fragility and heavy maintenance costs are intolerable. That's why General Electric's F. W. Rueblinger investigated the replacement of milling cutters with diamond abrasive wheels in his arc-quencher finishing operation. As Manager of Manufacturing of G-E's Medium Voltage Switchgear Department, Philadelphia, he was dissatisfied with having to maintain a large inventory of cutters and to keep men working around the clock sharpening and replacing them.

Arc-quenchers are made of a hard and extremely abrasive asbestos compound. This presented such a problem that all but one of the abrasive people consulted threw in the sponge. The one who didn't was Bay State distributor Vince Flynn. He arranged for key General Electric production men to meet with Bay State's Research Staff in Westboro and the problem was examined from every possible angle.

Finally, after extensive development work, Bay State engineered a special 12" diamond wheel that cut fast and maintained the extremely fine tolerances necessary in the finishing of these important parts of Metal-clad Switchgear.

With as many as 136 wheels on a single arbor simultaneously making ¼" deep cuts, the problem of driving power alone could have been disastrously troublesome. However, the wheels Bay State developed cut so easily that it was possible to increase the feed rate nearly 400% . . . and overall productivity went up a good 50%!

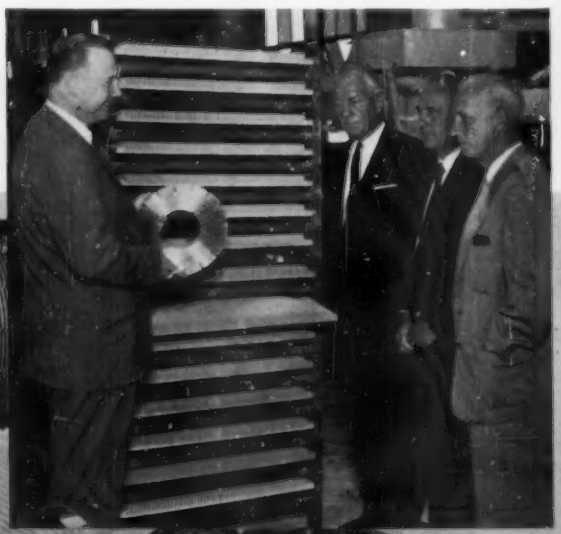
On top of these already proven advantages, wheel life is estimated at three full years so the constant down-time problems that used to arise from the need for cutter maintenance is entirely a thing of the past.

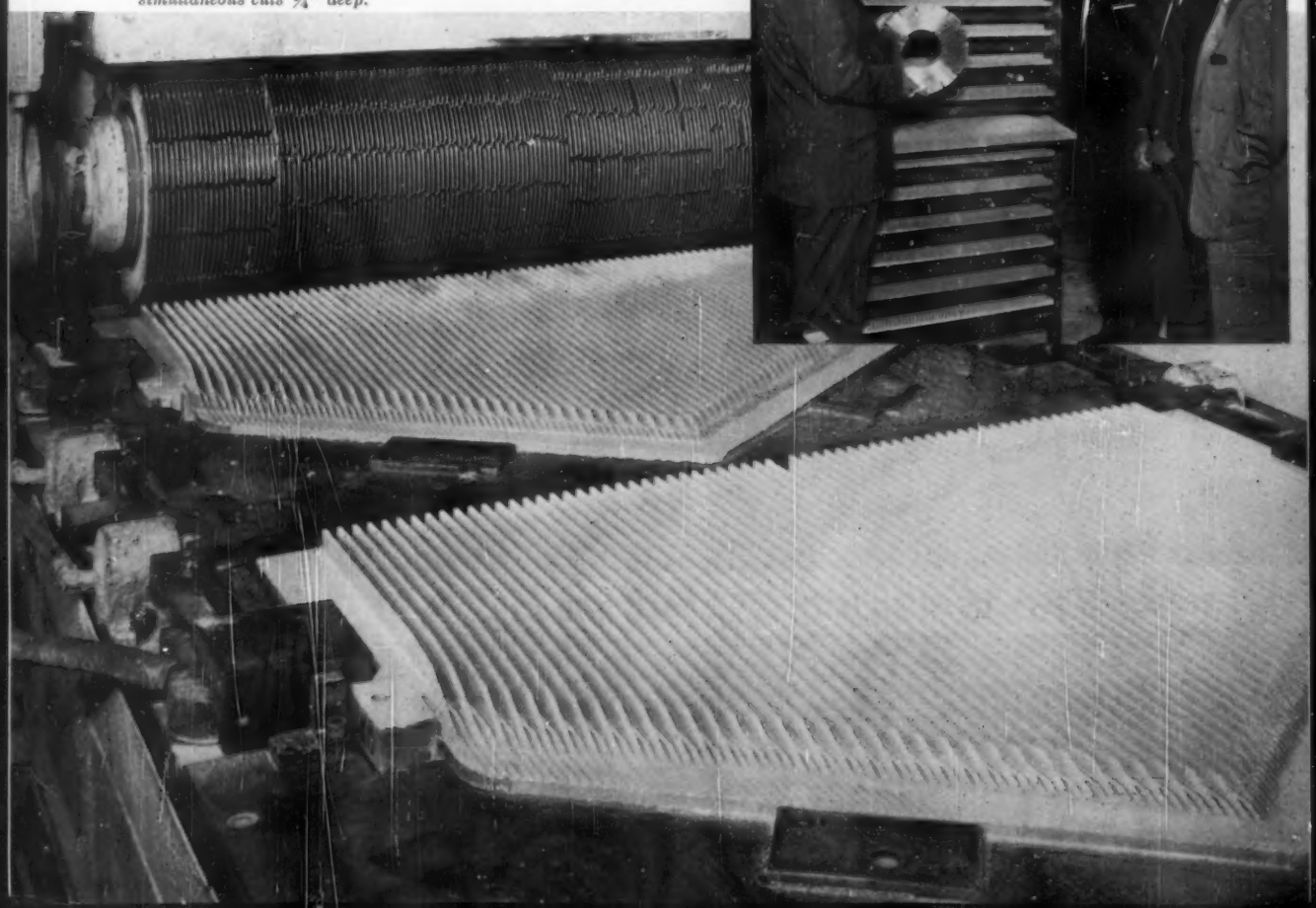
This outstanding success is not the end of the story. Now that General Electric's man-made diamonds are available for metal-bonded wheel applications, Bay State is engaged in intensive research into the even greater application potentials of this material.

Whether you have an unusually complex problem, or are simply trying to pare down costs, you'll find your Bay State distributor or direct representative is both hard-working and thoroughly experienced. *Better grinding at lower cost . . . that is his business.*

Right: Discussing the increased productivity that resulted from grinding, instead of cutting, hard asbestos-composition arc quenchers, are, left to right, Vincent J. Flynn, Bay State Distributor, F. W. Rueblinger, Manager-Manufacturing, John Stabb, Supervisor-Advanced Manufacturing-Engineering, and William A. Siter, Manager-Manufacturing-Engineering.

Below: Two arc-quenchers are shown immediately after passing under a tremendous array of 136 Bay State diamond wheels which have made simultaneous cuts ¼" deep.





diamond wheels ups productivity 50%

Vincent J. Flynn was a Tool & Die Maker at the Frankford Arsenal when World War II came along and he joined the U.S.A.F. With this solid background in practical shopwork, he went into industrial distribution after the war, opening up his own business 5 years ago. Now a highly successful Bay State Distributor, he has this to say about Bay State: "They not only give me and my customers first-class service on routine problems . . . they also roll up their sleeves and dig in every time I come up with a puzzler . . . like this one, for example."

BAY STATE ABRASIVES

BAY STATE WHEELS of PROGRESS

Bay State Abrasive Products Co., Westboro, Massachusetts.
In Canada: Bay State Abrasive Products Co., (Canada) Ltd., Brantford, Ontario.
Branch Offices: Chicago, Cleveland, Detroit, Los Angeles, Pittsburgh. *Distributors:* All principal cities.

Use Reader Service Card. CIRCLE 127

HEAT PROCESSING COSTS CAN PUT YOU OUT OF BUSINESS!

How efficient is your operation?

Engineers everywhere today are searching for areas to increase manufacturing efficiency and stem rising costs. Many are concentrating on heat processing and finding it to be a great offender in terms of waste.

Have you checked your operation recently? One of the easiest ways to do so is to call in a highly trained MOCO oven system engineer. He can point out many improvements in your operation and recommend the very best equipment to modernize your processing. Why not check with him today for more heat processing efficiency tomorrow!

YOU'LL WANT THESE BASIC OVEN FACTS IF YOU DO ANY OF THESE OPERATIONS . . .

MOLDING • FABRICATING • EXTRUDING • COATING • LAMINATING • RECLAIMING • MATERIAL PRODUCTION • RE-INFORCEMENT

This Fact Book by MOCO engineers on the basic operating principles of heat processing ovens should prove interesting. If you have specific questions, please write.

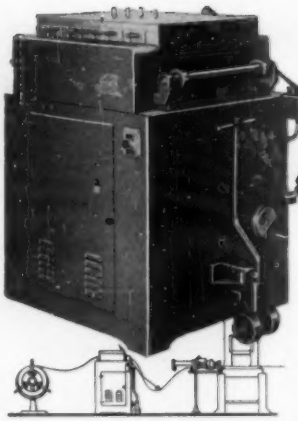
MICHIGAN OVEN COMPANY

MOCO

421 BRAINARD
DETROIT 1, MICHIGAN

Ad No. 61-2

Use Reader Service Card. CIRCLE 128



heavy duty stock straighteners

Cooper Weymouth variable speed power driven stock straighteners can increase production and reduce costs by removing coil stock curvature before feeding to presses, shears and four-slide machines.

All heavy duty models are portable, cabinet type; most take stock up to 3/16" thick and are made in stock width sizes of 12, 18, 24 and 36 inches. Free loop arm can synchronize straightener speed to that of other equipment.

Ask about other Cooper Weymouth time saving production equipment, designed to increase output, decrease costs.

COOPER WEYMOUTH, INC.
606 Honeyspot Road, Stratford, Conn.

Use Reader Service Card. CIRCLE 129

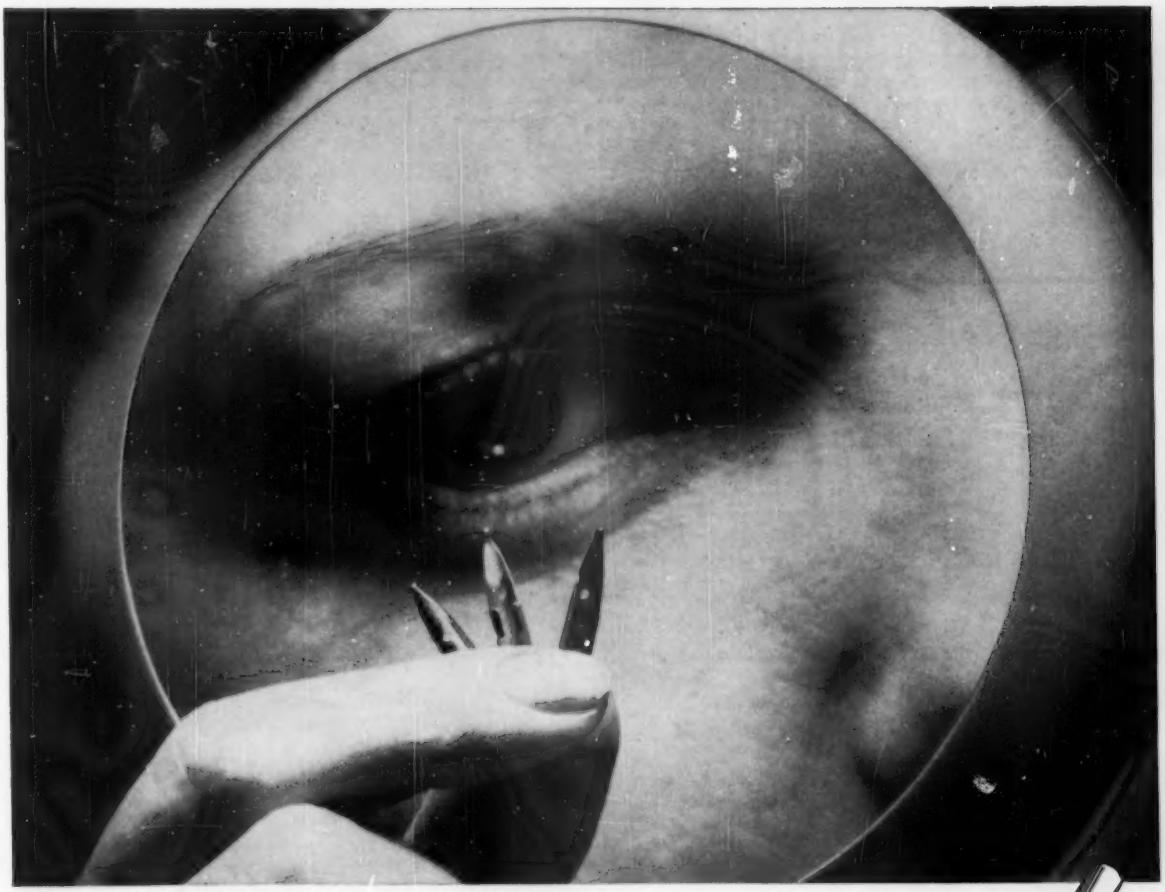
High Output with ROUSSELLE
DOUBLE-CRANK PRESSES

SPEED UP PRODUCTION with these versatile 40-ton presses. Large bed and ram areas make them ideally suited to handle wide rolls or sheets . . . do multiple punching, steel-rule die work and other high output operations. For rapid shockless starting and stopping, presses can be equipped with electrically controlled "Econo-Air" friction clutch . . . Ask for new catalog.

SERVICE MACHINE CO.
Mfrs. of Rousselle Presses
2310 WEST 78TH ST. • CHICAGO 20, ILL.

Rousselle Presses are sold exclusively through Leading Machinery Dealers.

Use Reader Service Card, CIRCLE 130



ALMCO Precision Finishing Gets to the Point.

At the Parker Pen plant in Janesville, Wisconsin, nibs for the famous Parker Pen are carefully examined (as shown). The writing surface must be flawlessly deburred and polished before being attached to the pen barrel in final assembly.

Almco precision finishing equipment does the job quickly and efficiently! Both conventional units and the new Vibratory machines are used at Parker to help make fountain pens that resist pressure, friction and abuse.

Almco's modern machines and methods—the Supersheen System—can help you achieve fine finishing results too. At Almco you receive trained counsel for your finishing problems . . . free sample processing in Almco's modern labs . . . skilled guidance in selecting the proper standard or custom-designed Almco machines and methods. Write today on your letterhead asking for an Almco sales engineer to call. Or send parts direct to Almco's lab with specs required.

Parker Pen barrels are Almco precision finished too! Almco Vibratory units can do the work 100 times faster than conventional finishing machines.

NEWS ABOUT ALMCO'S NEW PRODUCTS!

New brochures now ready on Almco spindle machine, Vibrasheen, other cost saving units. Price list on Almco compounds and media included. Send for your Almco Album of New Products today!

ALMCO

PRECISION FINISHING

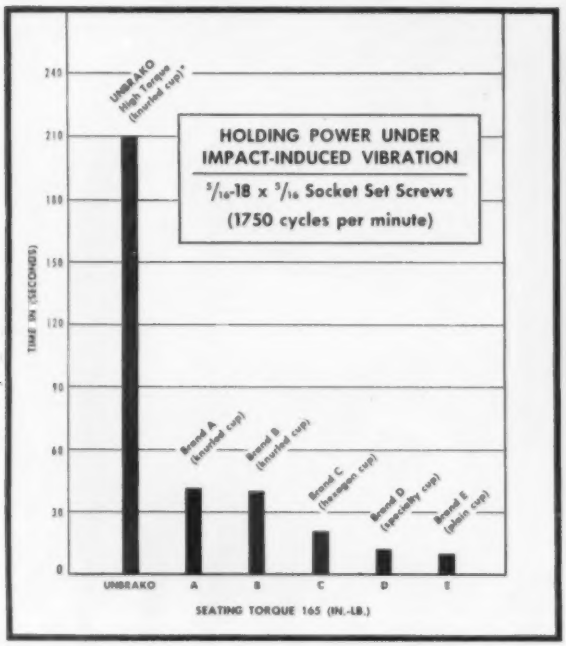
Queen Products Division • King-Seeley Corporation

1812 Marshall Street, Albert Lea, Minnesota

Use Reader Service Card, CIRCLE 168

Why you simply "set 'em and forget 'em" with UNBRAKO High Torque socket set screws

When you install a socket set screw, uppermost in your mind is probably this: Will it hold tight despite the vibration? Is it really on to stay or is there a good chance it will shake loose and cause damage and costly downtime? What about frequent stops for tightening? All worrisome questions. Yet the right answer is at hand.

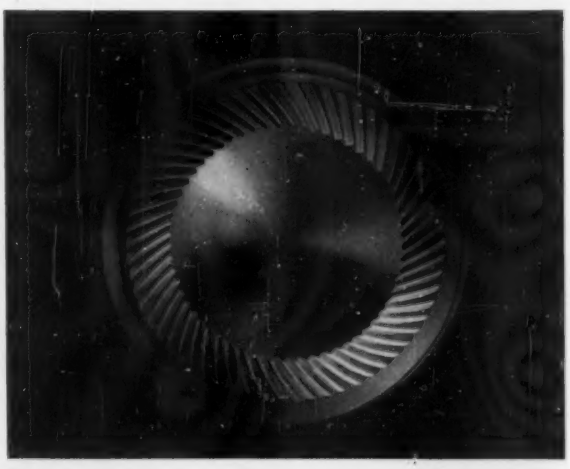


Tests conducted at SPS Laboratories for Advanced Research show UNBRAKO High Torque* with knurled cup point to be at least *five times as vibration resistant* as its closest competitor.

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (in.-lb.)

Screw Size	Unbrako	Set Screw B	Set Screw C	Minimum Differential %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
¼	87	62	60	40
5/16	165	122	125	32
⅜	290	198	225	29
7/16	430	309	350	23
½	620	460	500	24
5/8	1225	1106	1060	11
¾	2125	1540	1800	18
⅞	5000	3660	4600	9
1	7000	5025	6500	8

Note well that this test was held with all screws at the same torque. Now, when we realize that with UNBRAKO the tightening torques are as much as 40% higher than those for ordinary set screws, the gap between UNBRAKO High Torque and competitive brands becomes even greater.



Nor is there anything mysterious about the superiority of UNBRAKO. Certainly one of the main reasons—and one that the naked eye can perceive—is the exclusive knurled cup point, which enables this screw to grip with such tenacity that it is literally self-locking.

Other signally important features that help to explain UNBRAKO High Torque's unparalleled holding power:

- Fully formed threads with metal compressed into a closely knit grain structure and no straight lines along which shear can occur
- Precision heat treated steel to eliminate brittleness or decarburization
- Deeper sockets for maximum key engagement and wrenching power
- Radius sockets to eliminate sharp corners where cracks start during tightening

Give your assemblies every chance of operating at full efficiency . . . full time. Specify UNBRAKO High Torque.

* * *

UNBRAKO High Torque socket set screws are available for any application in sizes #0 through 1 in., in alloy and stainless steels, and with Nylok†. Your authorized industrial distributor has a *complete supply always on hand.* For further information, talk with him or write to Standard Pressed Steel Co. for booklet "More about UNBRAKO High Torque Set Screws." INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 37, PENNSYLVANIA.

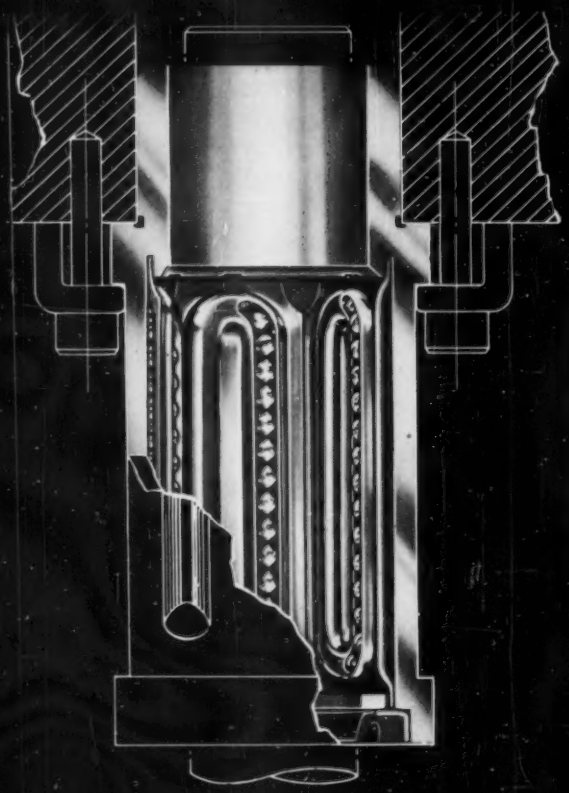
*Standard . . . they sell at regular price
†T. M. Reg. U.S. Pat. Off., The Nylok Corporation

SPS

where reliability replaces probability

Use Reader Service Card, CIRCLE 169

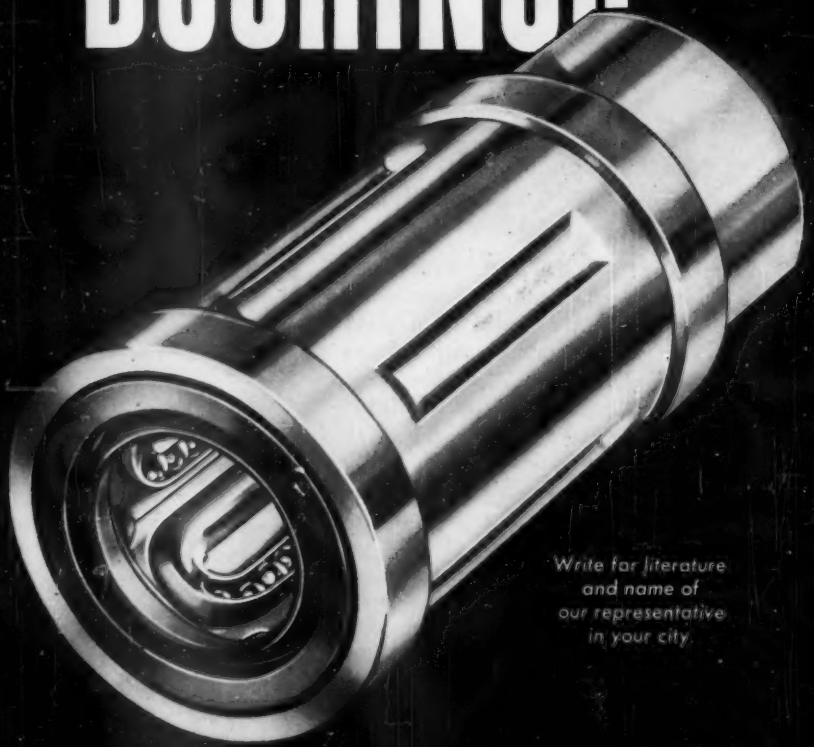
Use Reader Service Card, CIRCLE 170



THOMSON INTERCHANGEABLE die-set BALL BUSHINGS®

NEW!

GO ANTI-FRICTION
with a simple bushing replacement
and (1) Improve performance of your *present* dies
and (2) Reduce tool room costs



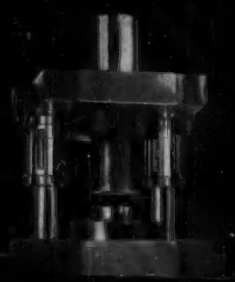
Write for literature and name of our representative in your city.

in the PRESS ROOM

Ball Bushings allow closer fits and maintain alignment which increases die life and permits longer uninterrupted runs. Fewer sharpenings and sustained parts accuracy also result. Periodic lubrication is eliminated and higher speeds are possible. Unlimited travel permits die to be used in any press regardless of stroke. Costly smash-ups due to seizure are eliminated.

in the TOOL ROOM

No cocking and binding... hence the punch holder "floats" on and off! No time consuming die jacking! Free-rolling ball bearings enable the toolmaker to actually "feel in" the fit of mating parts. This saves more time and makes better dies.



THOMSON INDUSTRIES, Inc.
Dept. D2, MANHASSET, NEW YORK

Makers of 60 Case hardened & ground shafting and NYLINED Bearings... Sleeve Bearings of DuPont NYLON

Two New Seminars

IN OUR OUTSTANDING 1960-1961 SERIES OF PROGRAMS

Quality Control
For Improved Production

5C54

JANUARY 11-12, 1961
CHASE PARK PLAZA HOTEL
ST. LOUIS, MO.

co-sponsored by
AMERICAN SOCIETY FOR
QUALITY CONTROL
and
AMERICAN SOCIETY OF TOOL AND
MANUFACTURING ENGINEERS

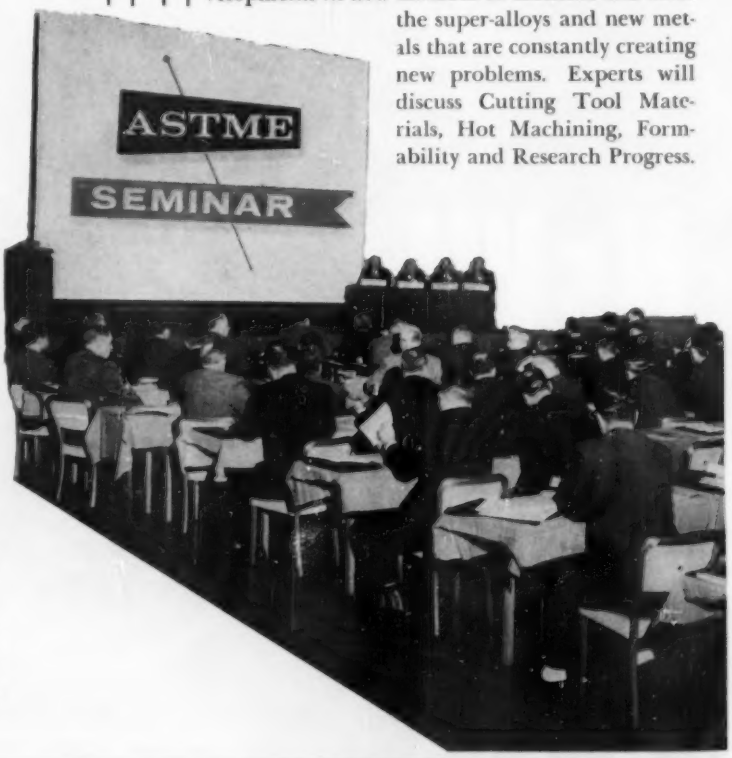
QUALITY CONTROL is the difference between a company maintaining a high standard of quality in its product or many product returns through poor workmanship. This Seminar on Quality Control will open with a paper on "Quality Control: The Master System for Improved Production," that will lay the foundation for the detailed methods, systems and case history reports that follow. Details on Air Gaging Systems, Nuclear Gaging, Automatic Control Systems and Optical Systems may provide the answers to your particular problems. Should it happen that your problem is particularly difficult, these experts will discuss it during an open forum panel discussion held at the conclusion of this Seminar.

Machining and Forming
Space Age Metals

5C55

JANUARY 18-19, 1961
STATLER HILTON HOTEL
DALLAS, TEXAS

An opportunity to learn of the most recent developments in new methods to machine and form the super-alloys and new metals that are constantly creating new problems. Experts will discuss Cutting Tool Materials, Hot Machining, Formability and Research Progress.



Please register me for _____

_____

Name _____

Position _____

Company _____

Co. Address _____

_____

☐ *Check Enclosed* ☐ *Bill My Company* *P. O. Number* _____

TO REGISTER

. . . fill out the form and send it to Gilbert E. Seeley, Education Director, ASTME Headquarters, 10700 Puritan, Detroit 38, Mich. Registrations must be made in advance. Confirmed registrations canceled later than two weeks before the Seminar are subject to a $10 service charge.

FEES: ~~$45~~ ASTME member
$60 non-member

Thompson's exclusive "CYBERMATIC PENDANT CONTROL" completely eliminates the elevating hand wheel

All vertical movement of the wheel head, both automatic and manual, on this modern Thompson 36 x 48 x 72 Type CX Plunge-Matic Grinder is accomplished effortlessly by dials on the Cybermatic Pendant Control.

This new pendant control performs the following functions: **Sets automatic down feed from .0002" to .006" in .0002" increments—sets the total amount of automatic down feed for stock removal from 0 to 1 inch through the entire 48" vertical capacity—controls automatic down feed increment (as pre-selected) at each reversal of the wheel head on cross feed or at each table reversal on straight plunge feed — controls a 20" per minute rapid traverse to the elevation of the wheel head—provides a push button to re-set the down feed range at operator's will — pre-sets a wheel dressing increment for automatic wheel trueing—compensates manually or automatically for wheel dressing —provides a master stop button for all movement.**

This Thompson machine is completely modern in every respect. Its features include the exclusive Thompson Hydra-Cool Hydraulic System with dual packless cylinders providing automatic cushioning. A separate automatic lubrication system for all sliding way bearings and tape bed way covers are standard equipment.

This modern Thompson grinder is both high powered and extremely accurate.

Further specifications will be furnished upon request.

PRE-LOADED
SELF-ADJUSTING
COLD RUNNING
ROTATIONALLY STABLE
VIBRATIONLESS
FREE FROM WEAR

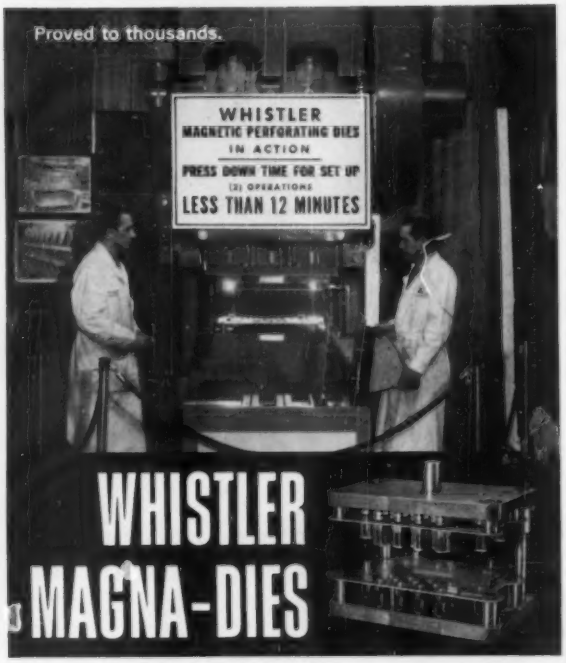
Thompson has taken another important step toward the ultimate in accuracy and precision by obtaining the exclusive use of the world famous MALCUS BLOCK BEARINGS for their wheel head spindles. The notable advantages of these bearings are listed above.

Thompson SURFACE GRINDERS

THE THOMPSON GRINDER COMPANY • SPRINGFIELD, OHIO

"Keep Thompson in mind for that daily grind"

faster changeovers boost press production



Whistler Magnetic Perforating Dies feature interchangeable parts fastened to steel templates which are patterned to the stamping. Punches and dies are assembled and disassembled in templates on an assembly bench while the presses are working on other production.

- **REDUCE DIE COSTS:** In one plant, over 1500 operations (for parts up to 3' x 5') have been tooled up at an average cost of $200 each.
- **EXTEND PUNCH AND DIE LIFE**
- **SAVE STORAGE SPACE**
- **ELIMINATE DELIVERY DELAYS:** Punches and dies stocked in .001" increments from .100" to .500" diameters. Other sizes in stock up to 3".

GET THE TIME AND MONEY SAVING STORY ON WHISTLER PRODUCTS:
magnetic dies • adjustable dies • custom dies

S. B. WHISTLER & SONS, INC.
744 Military Road, Buffalo 23, N. Y.

mail the following:
- ☐ Magna-Die Catalog
- ☐ Adjustable Die Catalog
- ☐ Custom Die Bulletin

NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE _____ STATE _____

Use Reader Service Card, CIRCLE 141

MAYLINE

Mayline Space Saving Wood Drafting Furniture!

For greater efficiency in the drafting room install Mayline wood drafting furniture.

With wood 4-Post tables, supplemented by wood plan files, there are seven possible space saving combinations. For complete particulars and prices see your dealer, or, write to factory for Folders S-17 and S-20.

MAYLINE COMPANY INC.
611 No. Commerce St. Sheboygan, Wisconsin

MAYLINE

Use Reader Service Card, CIRCLE 142

NEW BALANCING FACTS

Be sure to get copies of these two important new bulletins on Tinius Olsen balancing machines—including detailed information on the causes and correction of unbalance, and other fileable technical data.

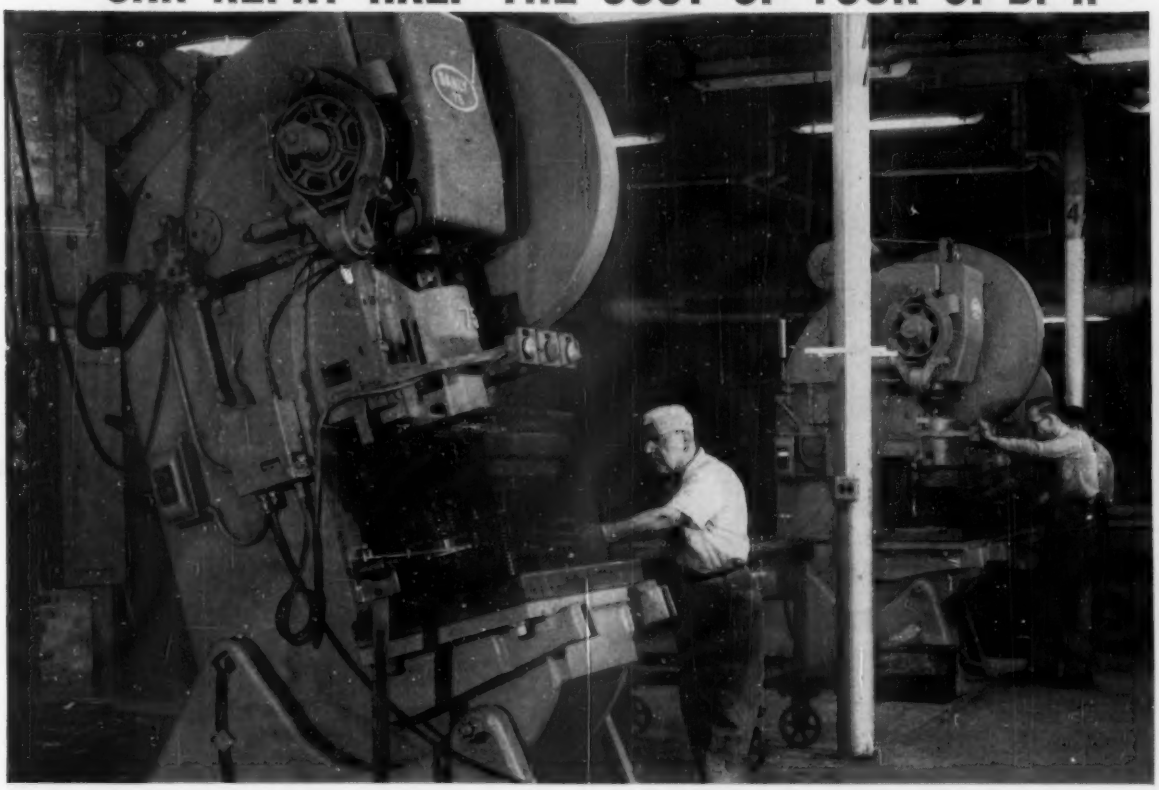
Write today for your copies of Bulletin 60 and "Tinius Talks about Olsen-Rava Balancing Machines."

TINIUS OLSEN
Testing Machine Co.
2110 Easton Rd. • Willow Grove, Pa.

Use Reader Service Card, CIRCLE 143

LESS FRAME DEFLECTION

CAN REPAY HALF THE COST OF YOUR O. B. I.



Is die life important on an O.B.I.? It certainly is! Die investment usually adds up to several times the cost of a press. Savings from just 15% or 20% improvement in die life is frequently enough to repay half your press cost.

This is why Danly O.B.I.s are built stronger, sturdier, to the industry's highest standards of rigidity. Danly O.B.I.s give you less frame deflection . . . more accurate die closure . . . longer die life . . . real savings in tooling costs! And other years-ahead design features, like Danly's exclusive low inertia air friction clutch, assure you of less downtime, lower maintenance costs, more dependable production.

Danly O.B.I. and gap frame presses have been setting remarkable performance records in the nation's largest press rooms for many years. Now this same Danly custom quality is available in a complete, standardized O.B.I. line, in capacities from 25 to 200 tons.

NEW CATALOG. For specifications and more facts, write today for your copy of the new Danly O.B.I. Press Catalog.

DANLY

DANLY

DANLY MACHINE SPECIALTIES, INC., 2100 S. Laramie Ave., Chicago 50, Ill.

WHICH NEW GEAR PROCESS WILL YOU HELP CREATE

Every new gear production process "we" pioneered in the last 3 or 4 decades—and there have been many—had its origin as a problem faced by one or more people like yourself—men who recognized the existence of a problem and came to Michigan Tool for the answer.

Lets go back to 1925 when automobile transmissions were so noisy that drivers couldn't hear themselves think over 30 miles an hour. Sales complained to management, management to engineering, engineering to manufacturing. They finally came to us and we put our engineers and research laboratory to work. You know the answer—gear shaving and the equipment that made quiet gears practical and economical.

Since those days, "Gear Production Headquarters" has poured out a steady stream of answers to the problems of men like yourself—answers like Shear-Speed gear shaping to make the cutting of toothed parts possible at high speeds; Roto-Flo cold rolling of all kinds of splines, threads and grooves in seconds instead of minutes—stronger and better than if machined; optical sine-line gear checking for either laboratory or on-the-floor control; Gear-O-Mation devices for automatic parts handling in process; double enveloping gearing to carry bigger loads with smaller gears; Ultra-Speed hobbing; hard gear finishing; giant shavers and hobbers to turn out gears up to 20 feet in diameter to almost unbelievable precision toler-

Michigan Tool Company

Use Reader Service Card, CIRCLE 146

?

ances to make ship drives quiet to protect against submarines; grinding equipment to make even "spherical" gears.

To make some of the new processes work even better we created new tools, new coolants; new plastics for gear hones, indexing tables which divide a circle into 5 million parts accurate to a fraction of a second; even text and reference books to make gear designing easier.

You too must have a problem . . . large or small . . . about processes, machines or even tooling. Perhaps our experience has already provided the answer. If we don't have it, we'll go to work on it. Chances are we'll come up with it as we have so often before. It's worth trying and *your* Company will benefit.

7171 E. McNICHOLS ROAD • DETROIT • TW 1-3111

Plants in: Detroit, Traverse City and Manistee, Mich. and Windsor, Ontario.

Gear Production: The most complete line of equipment for gear production offered by any manufacturer.

Hobbers and Shapers for Job Lots
High Production Hobbers
Shear-Speed Gear Shapers
Roto-Flo Cold Forming
Shavers for gears of ½" to 200"
Internal and External Form Grinders
Sine-Line Gear and Tool Checkers
Gear Chamfering Equipment
Abrasive Gear Finishers
Mitco Quality Gear Cutting Tools

Automation Equipment (Gear-O-Mation Division): Engineering and manufacture of simple and practical equipment for automating a plant, a line, or a machine. Pre-engineered units for orienting, storage, loading, unloading, assembling, conveying, escapements, positioning, elevating, feeding.

Form Grinding (Gear Grinding Machines Division): "Detroit" fully automatic form grinders for both external and internal contours—involute, cycloidal, spherical, straight sided.

Prototype Gearing (Enterprise Division): Spur, helical, bevel gears and splines for prototypes and in developmental quantities. Also contour form grinding, internal and external.

OTHER MICHIGAN TOOL DIVISIONS INCLUDE:

Cone-Drive Gears Division (double-enveloping worm gears, speed reducers, gear motors); Michigan-Lorenz Division (hobbers and shapers); Shear-Speed Chemical Products Division (coolants and cutting oils); Colonial Tool Co. of Canada Ltd. (cutting tools of all types).

PACKLESS

4-way, assembly eliminates seals, provides

50 MILLION CYCLES

of total reliability in Alkon's new Series A ¼" valves for vacuum to 200 psi air at

LOWEST PRICES

10-40% less for hand, foot, solenoid, pilot and bleeder actuators.

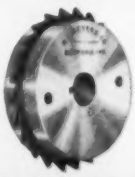
SUB-BASE MOUNTING FREE

Write today for new free 24 page catalog.

ALKON PRODUCTS CORPORATION
200 Central Ave., Hawthorne, N. J.
HAwthorne 7-6633

alkon

Use Reader Service Card, CIRCLE 147



SPECIALISTS IN

Carbide Tipped and Solid Carbide

CUTTING TOOLS

It costs no more to enjoy the production advantages of MEYCO tools: "precision" minded since 1888, careful workmanship, well equipped shops and capable design engineers . . . all add up to plus values for you.

The finest quality and proper grade of tungsten carbide is engineered to the cutter's job. Tools are precision ground and lapped for long life, tipped to carefully machined bodies balanced for rigidity. MEYERS works to tolerances of .0001", tipped cutters as thin as .030", solid carbide cutters much thinner, diameters of ¼" and up.

Your special problems in the field of cutting, slitting, slotting, under-cutting or form-cutting are solicited.

Write for new Cutter Catalog No. 52

MEYCO

W. F. MEYERS CO., Inc.
BEDFORD, INDIANA
A famous name in precision tools since 1888

Use Reader Service Card, CIRCLE 149

NEW

ALUMINUM

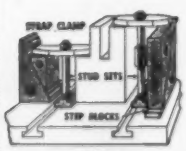
HEX-HUB

CAST-IRON

HAND—KNOBS

QUICK-ACTING FULL-THREAD SPIN-LOOSE

QUALITY AND LOW PRICES



ALSO
CLAMPING TOOLS
SURE-GRIP STEP BLOCKS OF
STEEL
WOOD
ALUMINUM

TOOLING BALL

MANY SIZES AND TYPES SAVES BUILDING AND CHECKING TIME

TTC

TIETZMANN TOOL COMPANY
315 N. Main St. Englwood, Ohio
Call TEmple 6-5141

Use Reader Service Card, CIRCLE 148

The 1961

ASTME

ENGINEERING CONFERENCE AND EXPOSITION

May 22-26

at

NEW YORK COLISEUM

THE AMERICAN SOCIETY OF TOOL and MANUFACTURING ENGINEERS

reduce costly manual labor with

CUSHMAN

AIR OPERATED CHUCKS

SOLD THROUGH INDUSTRIAL DISTRIBUTORS

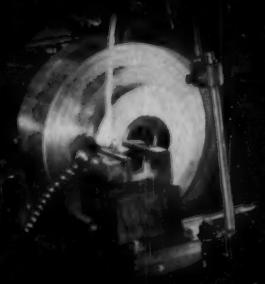
CUSHMAN CHUCKS . . . A PRODUCT OF AMERICAN QUALITY, LABOR, AND MATERIALS.

Manipulating a hand or foot air valve instantly opens and closes chuck jaws and eliminates tiring hand wrenching. In addition to reduced chucking time, Cushman Air Chucks do away with costly production slow-down and rejects due to operator fatigue and result in more profitable machining.

Completely safe, Cushman Air Operated Chucking Equipment is designed and built for rugged, continuous service and provides positive workpiece gripping with the advantage of being able to predetermine jaw pressure for the material being machined.

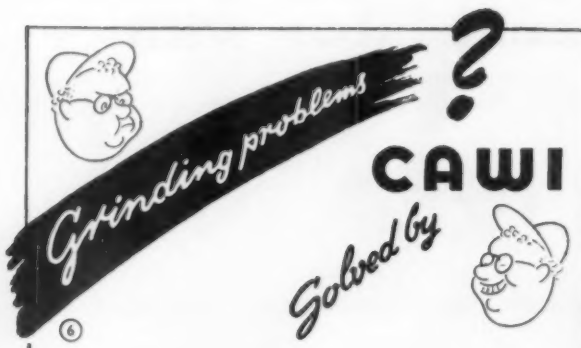
Other manufacturers have found that Cushman Air Chucks and Cylinders have effected outstanding production savings on both new and old equipment. Send for Bulletin No. PO-66D describing the many benefits and see for yourself.

THE CUSHMAN CHUCK COMPANY
Hartford 2, Connecticut



Manufacturers of Cushman Power Wrenches, Manually Operated Chucks and Face Plate Jaws

4CS60



Entirely new grinding possibilities! with the new

CAWI-SPIRAL
Model N 4-90 Z

In one set-up and one operation the pilot and the clearance angle on the new cutting phase is ground. Two-or multistep drills regardless of pilot diameter and pilot length are produced accurately according to specification using gauging device.

CAWI-SPIRAL
Model N 4-90 Z

Starting from standard drills, combination tool with different steps and clearance angles can be produced in one operation. Special dressing devices are available for profiling grinding wheels according to tool form specification.

CAWI-SPIRAL
Model N 4-90 Z

For grinding Ball point drills with or without pilot with additional cutting edges, the necessary radius dressing attachment available. With relief grinding device adjustable relief grinding of pilot possible.

CAWI-SPIRAL
Model N 4-90 Z

Concave and convex radii, intricate forms recesses can be ground. A pantograph controlled profiling attachment has been developed for the dressing of the grinding wheel. In one set-up all cutting edges and clearance angles are ground.

All these new possibilities are offered only with the new

CAWI-SPIRAL
Model N 4-90 Z

Please ask for details and tell us your grinding problems.

Territories Available

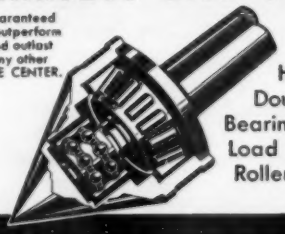
CAWI MACHINE CO., INC.

34 EXCHANGE PLACE JERSEY CITY 2, N.J. • TEL: HENDERSON 5-9330

Use Reader Service Card, CIRCLE 151

MARVECO LIVE CENTERS

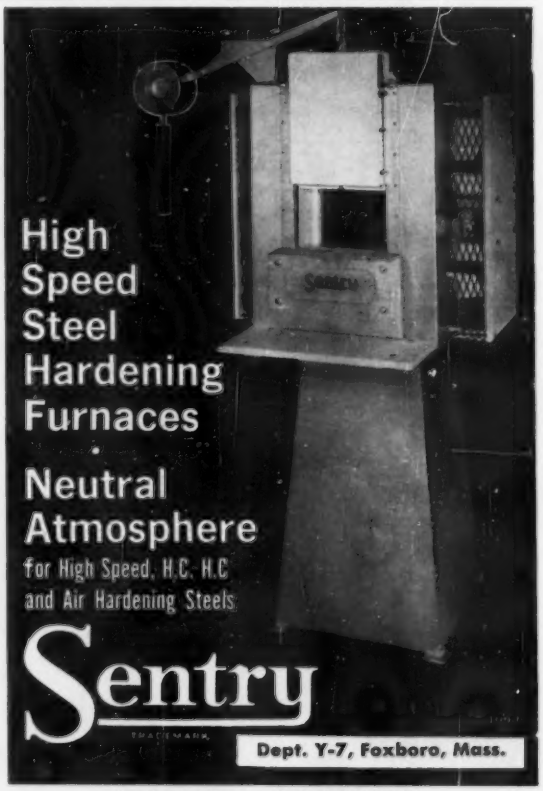
Guaranteed to outperform and outlast any other LIVE CENTER.



The WHOLE HEAD turns on Double Row Ball Bearings for Radial Load and Tapered Roller Bearings for Thrust Load.

MARVEL TOOL & MACHINE CO.
1086 North River Road • St. Clair, Michigan

Use Reader Service Card, CIRCLE 152



Use Reader Service Card, CIRCLE 153

DYKEM STEEL BLUE
Stops Losses making Dies and Templates

Popular package is 8-oz. can fitted with Bakelite cap holding soft-hair brush for applying right at bench; metal surface ready for layout in a few minutes. The dark blue background makes the scribed lines show up in sharp relief, prevents metal glare. Increases efficiency and accuracy.

Write for sample on company letterhead

THE DYKEM COMPANY
2303D North 11th St. • St. Louis 6, Mo.

Use Reader Service Card, CIRCLE 154

Hydraulic presses should work smoothly, with no jerk or erratic action. But sludge and varnish in an Eastern plant's presses caused uneven operation, with increasing "rejects."

A Sinclair lubrication engineer recommended Sinclair's new DURO hydraulic oils with oxidation, rust and foam inhibitors. Result: outstanding performance, with "rejects" cut to minimum.

Let Sinclair tackle (and solve) your plant problems. Call your local representative or write...

Sinclair

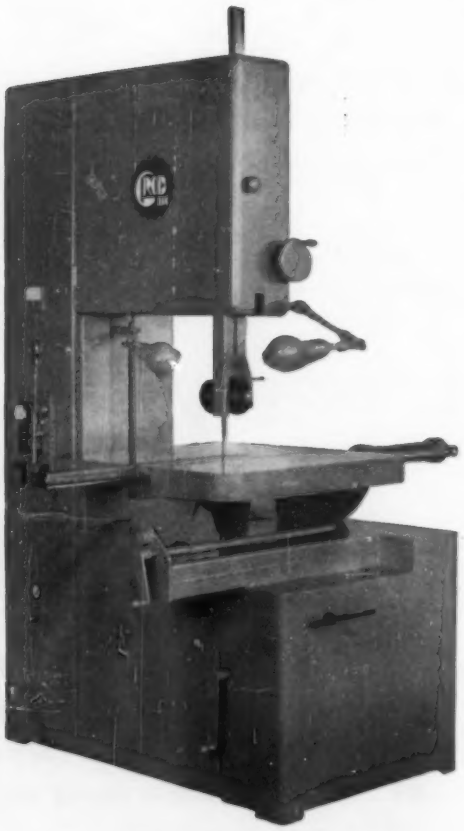
SINCLAIR REFINING COMPANY

TECHNICAL SERVICE DIVISION • 600 FIFTH AVE., NEW YORK 20, N.Y.

GROB SPELLS THE DIFFERENCE IN BAND SAW MACHINES

The new GROB 24" universal band saw
has all the famous GROB features:

Quality • Efficiency • Durability • Strength
Utility • Low Maintenance • Reasonable Cost



- Speeds infinite from 35-12000 FPM covers both cold and hot sawing
- Variable drive 3-speed transmission with precision rolled gears and splines transmits 15 HP
- Hydraulic table feed

See the difference demonstrated in our dealers' showrooms

or

Write GROB INC. for complete specifications

GROB also manufactures a complete line of:

BUTT WELDERS
FILING MACHINES
GEAR ROLLING MACHINES

GRAFTON, WISCONSIN

Punchability + REPORTS

Check Report Desired

☐ R. R. 22 **Tool Wear in Cutting Thin-Gauge Shee. Steels by Otto and Werner Kienzle**

Translation from German, made available by Armco Steel Co., embodies new data, tells of research in 3 groups of sheet materials, why rough punched faces are preferred. *Price .75 (non-member 1.50)*

☐ R. R. 23 **Superfinishing of Die Parts—What are the Advantages and Disadvantages? by E. Griffiths**

Summarizes replies received from a questionnaire sent to the Metal Stamping Committee. Highlights the wide difference of opinion held by authorities. *Price .75 (non-member 1.50)*

☐ R. R. 24 **Break Clearance Standards and Control by E. Griffiths**

Summarizes replies received from a questionnaire sent to the Metal Stamping Committee. Highlights the wide difference of opinion held by authorities. Price *.75 (non-member 1.50)*

☐ R. R. 25 **Proposed Test Method for the Determination of the Punchability Rating for Electrical Steels by E. Griffiths**

Discussion of the variables in punchability testing. Emphasizes the need for a more thorough understanding of the basic principles involved in measuring punchability. Outlines a suggested research project. *Price .75 (non-member 1.50)*

☐ R. R. 26 **Development of a Punchability Rating Method for Electrical Steels, Phase I by Professor John E. Biegel**

Covers Phase I of the research undertaken by Syracuse University. Initial test conditions are established. Seventy-five item bibliography included. *Price .75 (non-member 1.50)*

Clip, fill out and mail Today!

To: American Society of Tool and Manufacturing Engineers
Publication Sales Dept., 10700 Puritan, Detroit 38, Michigan

Ship to .....

Address .....

City ..... Zone ..... State .....

Chapter No. (if member) .....

Check, Money Order, or Company Purchase Order must accompany order.

USE
GATCO ROTARY BUSHINGS
WITH
Your Boring Bars
FOR
ACCURACY
and
SAVE WEAR

Eliminates expensive tool construction — Reduces tool wear — Prevents seizure and pilot breakage — Especially adapted where precision is required.

ORIGINATORS OF THE ROTARY BUSHING

GATCO ROTARY BUSING CO.

FOR DRILLING, CORE DRILLING, ROUGH AND FINISHED BORING

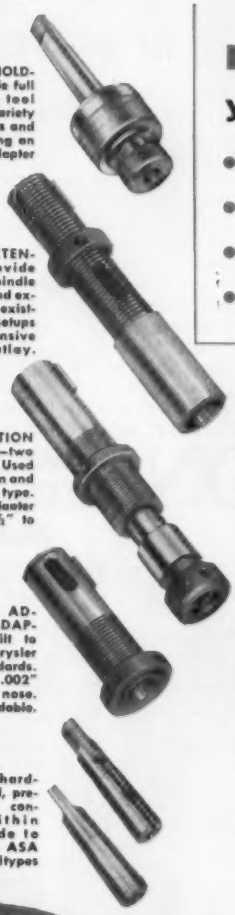
The inner race of the GATCO bushing rotates with the tool, piloting the tool accurately below or above the work—or both.

42324 ANN ARBOR ROAD, PLYMOUTH, MICH.
GLenview 3-2295

Use Reader Service Card, CIRCLE 159

When you specify SEIBERT HOLDING TOOLS you get

- ADVANCED DESIGN
- PRECISE WORKMANSHIP
- FINE MATERIALS
- QUICK SERVICE



FLOATING HOLDERS — provide full float, quick tool changes, a variety of shank types and sizes, including an adjustable adapter shank.

SPINDLE EXTENSIONS — provide individual spindle adjustment and extend or alter existing multiple setups without extensive retooling outlay.

DOUBLE-ACTION TAP DRIVERS—two tools in one. Used both as tension and compression type. Made in 6 adapter sizes from ¼" to 1⅜".

SHUR-LOCK ADJUSTABLE ADAPTERS — built to GMC, Ford, Chrysler and ASA standards. Concentricity .002" TIR 6" from nose. Sturdy, dependable.

DRIVERS — hardened, ground, precision built, concentric within .002". Made to automotive, ASA standards. All types and sizes.

These are the money-saving advantages of Seibert Production Holding Tools. And because of them, an excellent reputation has been built for these tools in many mass-production plants throughout the country — automobile, truck, tractor, agricultural implement, earth-moving equipment, etc.

In addition these advantages have influenced prominent machine tool builders to specify Seibert Holding Tools when tooling up machines being furnished to mass-production plants. They know from experience that Seibert Tools will meet the most exacting requirements of their customers.

Improved machining and other production methods make possible the quantity manufacture of these production tools to precise tolerances from fine alloy steel without increased cost to the user. In addition, this efficient production provides for meeting the needs of the user with unusual promptness.

You can investigate the advantages of Seibert Tools by telling us your requirements. Complete data will be sent at no obligation to you.

SEIBERT

SEIBERT & SONS, INC. 1003 E. 24th STREET CHENOA, ILLINOIS

Quality MULTIPLE DRILL SPINDLES AND PRODUCTION TOOLS

Use Reader Service Card, CIRCLE 160

HARDENED and GROUND HSS BLANKS

Any decimal diameter —in any length. Mirror finish surface to gage tolerance. Many uses— —core pins, punches, gages, ejector pins, insert pins, special tools, etc.— Quick delivery.

Write or phone: DRexel 6-4222 for price list D-4

WILLIAM T. HUTCHINSON CO.
53 Brown Ave. · Springfield, N. J.

Use Reader Service Card, CIRCLE 161

PUSH BUTTON *Speed Selection*

from to in seconds

or to *any* intermediate speed, *instantly*

Just push a button and watch the large tachometer dial on the headstock!

It's that easy!

The work is done by a motor driven speed changer. It accelerates or slows the lathe to any desired speed in seconds. With a 10:1 ratio, this new variable drive makes it easy to select from a wide range of speeds—200 to 2000 rpm in direct drive and 40 to 300 rpm in back gear.

Maximum stability and smooth power transmission are assured because the drive unit is oversized. All pulleys and shafts are fully supported (eight bearings). Double V-belts throughout the drive eliminate slippage and deliver full power to the spindle. Because of this rigidity and extra pulling power, this lathe will take heavy cuts at all speeds and precision finish cuts at high speeds.

It is a precision lathe, moderate in price, with the versatility for toolroom, production or second operation jobs.

SHELDON *Variable Speed* PRECISION LATHES

Illustrated WM56P 13" Swing- 34" Centers

Write for

"Variable Speed" Circular and General Catalog showing . . .

- 10", 11", 13" and 15" SHELDON Precision Lathes (Bench, Pedestal and Cabinet types)
- 13" and 15" SEBASTIAN Geared Head Lathes
- SHELDON Milling Machines
- SHELDON Back Geared Shapers

SHELDON MACHINE CO., INC.
4229 N. Knox Ave. • Chicago 41, Ill.

Use Reader Service Card, CIRCLE 162

If you're in metalcutting, you need this book . . .

METAL-CUTTING BIBLIOGRAPHY

. . . the most up-to-date work on chip producing processes

- 18,000 articles, papers, books in English and foreign languages reviewed
- 5,593 original articles abstracted for this edition
- The result of four years of research by The John Crerar Library in Chicago
- Beautiful library edition—hard cover, 1,000 pages, 8½" x 11" size

ORDER YOUR COPY NOW!

Please send check, money order or company purchase order.

*Name:*_____

*Company:*_____

*Address:*_____

Mail to: American Society of Tool and Manufacturing Engineers

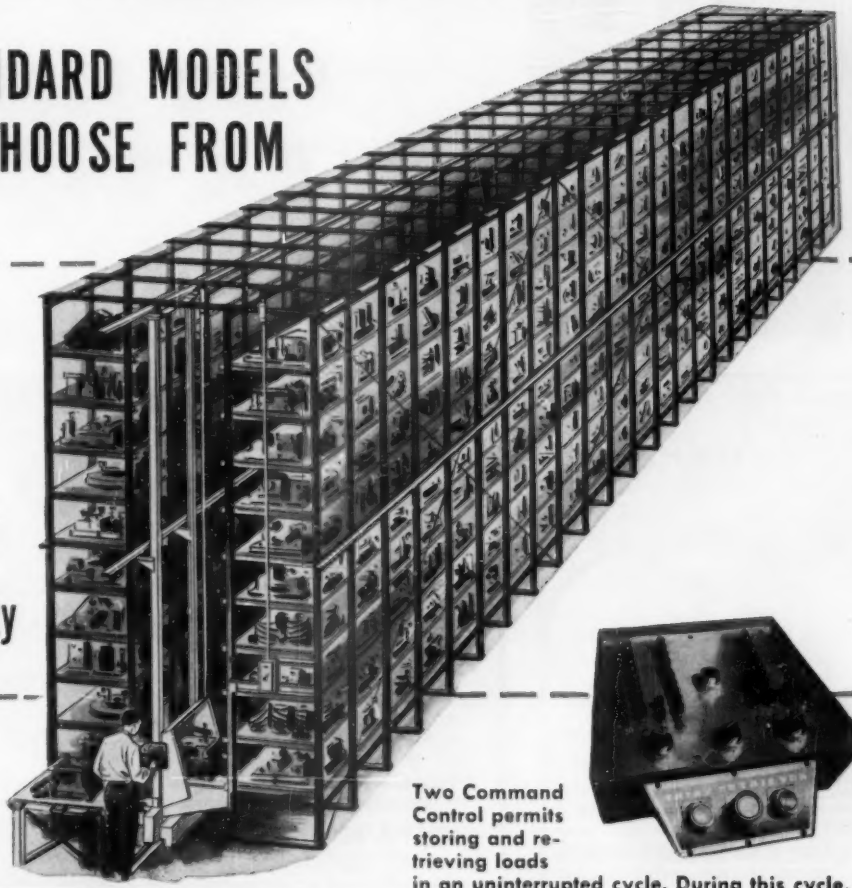
ASTME **RESEARCH FUND**

10700 Puritan Avenue
Detroit 38, Michigan

PUSH KEY MATERIAL HANDLING AND STORAGE with the TRIAX® RETRIEVER®

19 STANDARD MODELS TO CHOOSE FROM

Pre-engineered Modules... from 12′–24′ height 1000 lb. capacity



Two Command Control permits storing and retrieving loads in an uninterrupted cycle. During this cycle, the operator is free to perform other duties.

PERPENDICULAR DIMENSIONS	LOAD DIMENSION PARALLEL TO AISLE 18″	24″	30″	36″	42″
24″	R34	R44			
30″	R35	R45	R55		
36″	R36	R46	R56	R66	
42″	R37	R47	R57	R67	R77
48″	R38	R48	R58	R68	R78

Other units are available up to 2500 lb. capacity. For further information write or call . . .

RANDOM STORAGE . . . PINPOINT LOCATION

Floor-to-ceiling storage with a Triax Retriever can save up to 70% plant area or labor . . . and offers immediate access to parts, tools, dies or inventory in storage.

The R-46 illustrated contains 460 openings with a total of 2760 square feet of storage space. It occupies only 550 square feet of floor space. Load height is 13″ including a 1″ slab pallet, but can be varied to meet your needs.

Triax now offers a wide range of R-Series Retrievers to fit your individual requirements.

THE TRIAX COMPANY

SWeetbriar 1-9800

11955 SHAKER BLVD. • CLEVELAND 20, OHIO

TOOL CRIB SECTION

A Compact and Handy Source of

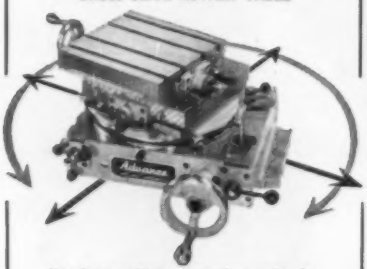
New Product

and Service Information

Since 1954, The Original

Advance.

CROSS SLIDE ROTARY TABLE



Has been cutting set-up time costs, improving precision in hundreds of DIE, MOLD and TOOL SHOPS. A profitable investment for your shop . . . investigate today.

Built Only by

ADVANCE PRODUCTS CORP.

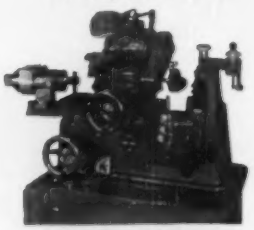
BENTON HARBOR, MICHIGAN

Use Reader Service Card, CIRCLE 601

HYBCO

TAP GRINDER

Sharpens Chamfers, Flutes and Spiral Points



MODEL 1100

• Capacities No. 0 Machine Screw to 2½" Hand Taps. Write for Catalog.

HENRY P. BOGGIS COMPANY

711 E. 163rd St., Cleveland 10, Ohio

Use Reader Service Card, CIRCLE 603

TAP SPECIALISTS

THREADING IS OUR BUSINESS

ROYCO Precision Ground Taps are engineered for your particular job. ROYCO TAPS are ground entirely between centers using precise machines and tooling. High Quality is not sacrificed for mass production methods.

ROYCO stocks a large supply of special taps ready for immediate delivery plus a complete line of standard taps and thread gages.

All types are ground—including acme, square thread, buttress, etc.

SPECIALISTS IN ACME TAPS.

Send for Catalog 27 today.

Royco

Service will save you money

ROYCO TAP & TOOL CORP.

BOX 2658 PHONE 2210 NORTH BRANCH, MICH.

Use Reader Service Card, CIRCLE 605

BAIRD

AUTOMATIC MACHINERY BUILDERS SINCE 1846

AUTOMATIC MILL

Precision Machine 3,000 Parts Per hr !

New BAIRD machine automatically mills rugged tool blanks or small electronic parts at high speeds with accuracy duplicated to ±.001".

AUTOMATIC MILL INCORPORATED

Danbury Industrial Park, Danbury, Conn.

Use Reader Service Card, CIRCLE 602

RED-E ... YOUR BEST SOURCE FOR JOB PROVEN CENTERS

It's a safe bet READY has the right CENTER for your job, whether it's on a lathe, grinder, miller, spinner, screw or gear cutting machine.

Economize with RED-E

OVER 250 TYPES, TAPERS & SIZES ANTI-FRICTION OR SOLIDS. CAP. TO 200 TONS, SPEEDS—4,000 r.p.m.

CALL YOUR DISTRIBUTOR OR WRITE

CENTER specialists since 1908

RED-E-TOOLS

READY TOOL CO.

158 Garfield Ave., Stratford, Conn.

Use Reader Service Card, CIRCLE 604

CECOR formerly Carnes

COOLANT HANDLING EQUIPMENT

ULTRASUCTION

removes chips, coolant sludge, oil from machine tool sumps. Large portable tank units offer filter option. Portable units, air or electric powered, collect sump waste for disposal or reclamation. Power heads convert 55 gallon drums into high suction Coolant Sump Cleaners. Six models for all applications handle abrasive waste without pump wear. Write today!

DLO

VERONA, WISCONSIN

COOLANT EQUIPMENT CORPORATION

Use Reader Service Card, CIRCLE 606

The Tool Crib Section is an aid to readers in selection

and specification of new products and service organizations

to complete their manufacturing and production programs.

TOOL CRIB SECTION

economically priced press room equipment

DURANT
Automatic Stock Reels

Operates by natural spring of uncoiling stock. Priced from $85.00. Nine other models of stock reels in vertical, horizontal, motorized or automatic types for all applications.

Manufacturers of Stock Reels, Roll Feeds, Straighteners, Scrap Choppers, Die Pullers, Foot Presses, Coil Cradles, Press Guards, Stock Oilers.

WRITE FOR NEW FREE CATALOG

DURANT TOOL COMPANY
PROVIDENCE 5, RHODE ISLAND

Use Reader Service Card, CIRCLE 607

Raymac

PREMIUM QUALITY

SOLID CARBIDE CUTTING TOOLS

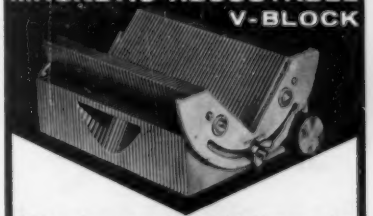
NEW 1961 CATALOG

SEND FOR YOUR COPY

WRITE
RAYMAC DIVISION
DEXCO CORPORATION
15778 Telegraph Road
Detroit 39, Michigan

Use Reader Service Card, CIRCLE 609

MAGNETIC ADJUSTABLE V-BLOCK



This unique precision workholder permits quick and accurate setups, saving time, effort and money in grinding operations.

Unsurpassed for layout, toolroom and production. Can be used on any machine equipped with magnetic chucks.

COMPARE THESE DISTINCTIVE FEATURES:

- Parallelism: ± .00005" over entire length
- Maximum setting: 90° angle
- Vernier accuracy: ± 15 seconds
- Size: 6" long, 4½" wide, 2½" high

Write today for complete technical data to:
ANTON MACHINE WORKS
1226 Flushing Ave., Bklyn. 37, N. Y.

Use Reader Service Card, CIRCLE 611

LINDERME 2-SPINDLE ADJUSTABLE DRILLING & TAPPING HEAD

Drills, taps metal, wood and plastic. 2-minute setup on most drill presses. Variety of models from ½" to 12⅝" centers, adaptation to large or small drill presses with sleeve or over-arm guide pins. Mounted to cast iron base with surface ground for drill fixture use. Also used with standard tapping heads. Multiple head with fixed center distance are designed and built to your requirements. Available with S-J Sleeves, Morse taper or drill chucks. *Write for complete information today.*

LINDERME ENGINEERING & SALES
8132 Puritan • UN 3-4979 • Detroit 38, Mich.

Use Reader Service Card, CIRCLE 608

IT WAS A STEP FORWARD
When grampa changed from the

Old Flat Drill to the

Modern Twist Drill

IT WILL BE ANOTHER STEP FORWARD

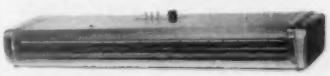
When YOU change from the
Old Hook Type Boring Tool to the

Modern Precision Boring Tool

BONUM TOOL CO. INC.

Use Reader Service Card, CIRCLE 610

WHITE PRINTS
at 1½c per sq. ft.
with the NEW
electr-o-line
rotary diazo white printer



- No warm-up time
- Emergency reverse
- Variable speed control
- A clear, translucent and unbreakable development tube.

Write today for complete details

Dept. TE
Warren
Electr-O-Line Corporation
7419 Grand River, Detroit 4, Mich.

Use Reader Service Card, CIRCLE 612

TOOL CRIB SECTION

A Compact and Handy Source of

New Product

and Service Information

DO YOU HAVE A DIAL INDICATOR THAT IS SICK?

Got a Dial Indicator that's misbehaving? A Height Gage or Dial Bore Gage that's no longer accurate? Whatever your problem, DWIGHT can make it right! DWIGHT can save you time and money on the repair of all makes and types of precision measuring instruments. One source for all makes and models saves you paper work. Deliveries are far better than from the manufacturer . . . and prices are lower, too.

DWIGHT WILL MAKE IT RIGHT

DWIGHT INSTRUMENT CO.

593 New York Ave. Lyndhurst, N.J.
Phone: GEneva 8-3334
Authorized BROWN & SHARPE Repair Service

Use Reader Service Card, CIRCLE 614

Solve your AUTOMATION PROBLEMS with JS
AIR OPERATED INDEXING TABLE AND COLLET FIXTURES

MODEL 2A-2 WITH 12" TABLE

POSITIVE, RAPID INDEXING BY SIMPLIFIED SEQUENCING METHOD IN MULTIPLES OF 15° . . . IDEAL FOR MECHANICAL OR TAPE CONTROL OPERATION . . . WRITE TODAY FOR LITERATURE.

James Smith & Son, Inc.

MACHINE BUILDERS SINCE 1907
988 SOUTHBRIDGE STREET
WORCESTER 10, MASS.
PL 5-3760

Use Reader Service Card, CIRCLE 616

TOOL ENGINEERS HANDBOOK 2nd Edition

CURRENT
COMPREHENSIVE
INDEXED

The Tool Engineers Handbook, the most modern, authoritative 2,289 page reference of its kind, was updated and revised by 387 qualified and experienced authors. The Handbook contains 103 sections; 219 additional pages have been added.

This expanded volume informs readers on new subjects: Chemical and spar milling, sandwich-structure aircraft development; automation, and arc-and-spark machining.

Provides Answers

This informative handbook will assist active Tool and Manufacturing Engineers, it will help you make correct decisions regarding:

Product Design
Production Planning & Control
Economics
Work Setup: Jigs & Fixtures
Material Handling
Testing & Inspection

2,289 PAGES
1,709 ILLUSTRATIONS
609 TABLES

	Prices
ASTME Members	$15.00
Non-Members	$19.50

CLIP, FILL-OUT MAIL TODAY

Please send the ASTME Tool Engineers Handbook to:
Name .....
Address .....
City ..... Zone ..... State .....
Chapter number (if member) .....
Prices: ASTME Members - $15.00 - Non-members - $19.50

NEW— special cutting tools catalog

fully illustrated

FEATURES: 45 pages of special cutting tools. Plain Milling Cutters, light and heavy duty. Helical Milling Cutters. Side Milling Cutters, staggered teeth, half side, interlocking. Metal Slitting Saws, hollow ground, side chip, staggered teeth and many other specials.

Write Dept. T for your Catalog Today

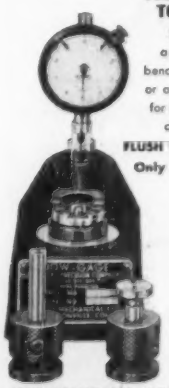
F & D Tool Co., Inc. THREE RIVERS, MASS.

Use Reader Service Card, CIRCLE 615

EDUCATED FLUSH PINS

FOR TOLERANCES TO ±.00025

Snap them into a Dow-Gage for bench checking . . . or a tacamp stub for in the machine checking . . .



FLUSH PIN BLANKS Only $15.00

For Information Write:

DOW

DOW MECHANICAL CORP., THOMPSONVILLE, CONN.

Use Reader Service Card, CIRCLE 617

the TOOL and MANUFACTURING ENGINEER

1960 ANNUAL INDEX

Technical Articles

Volumes 44 and 45

This index lists subjects treated in the Technical Section and Tech Digests department of the magazine. Divided into two parts, the index conveniently contains an author's index and a subject index. The former lists the titles and page numbers for each authored article, arranged alphabetically by author. The latter is cross indexed for easy reference and indicates by an asterisk those items less than one page in length. Important subtopics are indexed along with major subjects so that references to a desired subject may be located easily with a minimum expenditure of time.

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS
10700 PURITAN AVENUE, DETROIT 38, MICHIGAN

1960 AUTHOR INDEX

—A—

Adams, F. A.—Combination Clamp*, Jan. p. 82
Poured Epoxy Shedder Reduces Die Costs*, Oct. p. 78
Akers, R. M. and S. S. Smith—How To Determine Optimum Feeds and Speeds, June, p. 105
Amstead, B. H.—Controlling Bar Stock Whip, May, p. 89
Anderson, A.—Rubber Spacer Holds Parallels*, Jan. p. 80
Attig, John B.—Scribing Blades Facilitate Checking, Feb. p. 103

—B—

Bachman, H. A. and L. L. Linzell—Cast-to-Size Dies Prove Economical, Jan. p. 111
Backer, W. R.—Balancing of Grinding Wheels, Oct. p. 95
Ballinger, J. R. and J. C. Gorham—Numerical Control for Design*, Apr. p. 329
Barlow, Joel—Effective Depreciation Legislation, May p. 213
Barkett, Francis E.—Drilling Fixture*, Aug. p. 48
Baxter, Thomas—Expanding Mandrel*, Apr. p. 90
Bennett, Edward D.—Setscrew Orientator, May p. 86
Bethke, Al and Don Hochgreve—Slot Cutter, June 15, p. 78
Bidigare, George and John H. Shoemaker—Nitriding for Wear and Fatigue Resistance*, Oct. p. 195
Black, T. W.—Cutting Forging Costs, Feb. p. 94
Control: Key to Efficient Mass Production, Apr. p. 73
Toolmaking Without Machining, June p. 101
High-Production Job Shop—A New Concept in Manufacturing, Aug. p. 45
Planning for Productivity, Sept. p. 79
Mesons, Magnets and Manufacturing, Dec. p. 37
Bohannon, Raymond D.—Selecting Springs from Stock Lengths, Jan. p. 101
Bo-Linn, George—Hydraulic Arbor*, June 15, p. 82
Boosman, Floyd T.—Tool Flanges Internal Tabs*, Nov. p. 78
Borgers, Emil R.—Process Control Programming*, Dec. p. 155
Bossman, Cliff—Depth Gage*, Feb. p. 77
Breen, John M.—Trolley Brake*, Feb. p. 79
Adjustable Stop, Mar. p. 79
U-Bend and Form Die*, May p. 85
Use for Old Tape*, June p. 83
Quick-Change Gears*, Aug. p. 40
Low-Cost Bending Fixture*, Sept. p. 88
Briggs, Charles W., D. K. Wright, Jr. and Harry R. Nare—Comparison of Steel Castings and Weldments*, Sept. p. 261
Broatch, J. Stewart—Numerically Controlled Inspection, June p. 91
Brooker, Robert E.—Innovation and Obsolescence*, Sept. p. 257
Brown, Robert D.—Predicting Surface Finishes, Nov. p. 81
Browning, James A.—Plasma Flame Speeds Metalworking, April p. 105
Brugger, Frank L.—Shorter Tool Life Doubles Machine Productivity, June p. 84
Bryan, B. J.—Epoxy Dies for Explosive Forming, Feb. p. 97
Burch, William L.—Recognizing Fracture Patterns*, Aug. p. 143
Butler, C. A.—Marketable Inventions*, Nov. p. 229

—C—

Calebaugh, W. and E. Scerbo—In-Process Inspection—A Must in Missile Machining, May p. 109
Campbell, John W., Jr.—Science Fact or Fiction, Nov. p. 232
Carbonaro, P. A. G., and S. Valencia—Cold Swaging Extends Design Horizons, Apr. p. 113
Christensen, A. E.—Method Control in Testing—Key to Reliability, Dec. p. 61

*Brief article less than 1 page

Chyle, John J.—New Welding Process*, Oct. p. 198
Colgrove, Ralph—Lathe Fixture*, Aug. p. 39
Collins, G. Bruce—Building-Block Automation Applied to Broaching, Jan. p. 77
Conley, A. E.—Wrench Tightens Hard-to-Get-at Screws*, Dec. p. 45
Conn, Harry—Stick-Slip—What It Is, What To Do About It, July p. 61
Corkigian, Archie—Stock Guide*, Jan. p. 80
Cox, Floyd A. and Ernest F. Mellinger—Explosive Forming*, July p. 141
Curtis, M. S.—The Importance of Design in Development of Industrial Equipment*, May p. 214

—D—

Dahl, Hjalmar—Forming and Bending Die*, Jan. p. 83
Drawing Die*, Feb. p. 80
Simple Piercing Fixture Replaces Cam*, Nov. p. 80
Cam Die Pierces Multiple Holes*, Dec. p. 48
Dallas, Daniel B.—More Holes, Fewer Fixtures, Sept. p. 97
More Punch, Fewer Problems, Sept. p. 119
Daly, Robert E.—Hinged Sine Bar, July p. 45
Delamater, Eugene—Does Gun Drilling Pay? June p. 88
Dickson, Robert M.—Multiple Gage Speeds Inspection*, Oct. p. 76
Universal Drill Jig*, June p. 83
Dodge, James H.—Weight of Bar Stock is Quickly Calculated, Mar. p. 95
Douglass, T. E.—Vibrations Cause Grinding Rejects, Jan. p. 109
Dunleavy, J. G. and H. J. Wagner—Hydrospark Forming—Evolution of the Process, Mar. p. 83
duPont, Henry B.—Fundamentals of Technology*, Sept. p. 260

—E—

Edminston, Robert B.—Vibration and Sound*, Aug. p. 144
Eldridge, W. Russell—Gage for Trepan Grooves*, Feb. p. 80
Combination Trepan Gage*, Apr. p. 87
Ellis, J. L. and S. Tarkan—Machinable Carbides Solve Wear Problem, Nov. p. 99
Epprecht, J. E. and Harry E. Zimmer—Processing, Aug. p. 67

—F—

Feddersen, E. W.—High-Energy Rate Forming*, —Sept. p. 262
Feigenbaum, A. V.—Total Quality Control*, Apr. p. 339
Fiedler, F. E.—Preventive Maintenance*, Nov. p. 224
Field, Michael—Trends in Aircraft and Missile Metal Removal Techniques*, Sept. p. 261
Flatow, Paul Lloyd—How Common is Common Sense*? Apr. p. 329
Fromson, R. E.—Productivity Improvement*, Nov. p. 223

—G—

Geijer, Ernst and Roy S. Jamison—Machinability of Sintered Iron*, Aug. p. 143
Gerber, H. J.—Graduating Machine, Apr. p. 88
Duplex Taper Mandrel, June 15 p. 81
Portable Drill Eliminates Secondary Machining, Oct. p. 77
Auxiliary Jigs Cut Tooling Costs, Oct. p. 102
Drill Attachment*, Nov. p. 79
Plate Increases Gage Accuracy*, Dec. p. 46
Gershman, George—Direct Measurement of Taper, Jan. p. 85
Gliebe, Joseph—How To Estimate Bandsawing Costs—Oct. p. 114
Goerold, E. L. and J. Ropitzky—Modern Machining of Cannon, Nov. p. 107
Goldbeck, Carl W.—Project Justification and Evaluation*, July p. 142
Good, Charles H. and Frank W. Kahat—Stylii and Roughness Measurement*, Sept. p. 257
Goodfellow, Glenn B. and Jerome F. Kuzmick—Bonding Carbide To Steel*, Aug. p. 143
Gorham, J. C. and J. R. Ballinger—Numerical Control for Design*, Apr. p. 329
Grant, A. G.—Small Parts Feeder*, Sept. p. 89
Grayson, Edward W.—Drilling Method*, Jan. p. 81
Greene, James H.—Industrial Communications—An Engineering Approach, Mar. p. 75
Gregg, Herbert—Putting Gun Reaming To Work, July p. 47
Greve, John W.—Tooling for the Handicapped—A Challenge to Engineers, June p. 71
More Chips, No Chatter, Sept. p. 91

—H—

Hadley, C. A.—Tool Life of Single-Point Tools, June p. 117
Calculating Life of Milling Cutters, July p. 85
Haggerty, Andrew—Drill Symmetry—Effects on Hole Production, June 15 p. 83
Hall, A. M.—Use of High-Speed Steels*, Oct. p. 197
Harleman, Dorsie C. and A. Frank Watts—Why Form Explosively? Apr. p. 109
Harris, Louis H.—Designing Harmonic Cams, Dec. p. 81
Harris, W. R.—Progress In Industrial Automation*,—July p. 141
Hauck, H. G.—Numerical Control Applications, Nov. p. 226
Hays, Lawrence C.—Metalworking Lubricants, June p. 207
Heinmann, Heinrich—Analysis of Cutting Force—A Work-Energy Approach, Mar. p. 101
Helstrom, H. A., Jr.—Paperwork Simplification*, Aug. p. 145
Herchenroeder, L. W.—Electrical Systems for Electrohydraulic Forming*, July p. 142
Heslen, Robert—Control: Key to Efficient Small-Lot Production, Apr. p. 82
Numerical Control Increases Turret Lathe Output, May p. 117
Bigger Cuts, Better Controls—Sept. p. 107
Faster Metal Removal to Millionths, Sept. p. 112
Computer Takes Over—For Product Design and Manufacturer, Nov. p. 86
Contours Without Computers, Dec. p. 52
Hiltbrand, Carl R., Jr.—Drill Stand, Mar. p. 80
Hochgreve, Don and Al Bethke—Slot Cutter, June 15 p. 78
Hoffman, Leslie—Combined Operations—Key to Cost Reduction, Feb. p. 87
Eliminating Secondary Operations—Short Cut to Greater Efficiency, Aug. p. 35
Hyman, I. Harry—Chapters Get Behind Apprentice Program, Oct. p. 131

—I—

Ingham, Wendall, T.—Key Holds Cutting Tool During Backfacing, Dec. p. 47
Isetts, Roger—Tap Holder*, Jan. p. 83
Special Center*, Mar. p. 77
Stop Simplifies Part Positioning*, Nov. p. 78
Index Fixture Drills Different Parts*, Dec. p. 47

—J—

Jamison, Roy S. and Ernst Geijer—Machinability of Sintered Iron*, Aug. p. 143
Jatczak, C. F. and O. A. Pfouts—Welding Renews Damaged Dies, July p. 77
Johnson, Allen M.—Twin-Fulcrum Lever, Mar. p. 78
Multipiece Gage*, Apr. p. 89
Gaging Movement*, Aug. p. 38
Johnson, Russell V.—Determining Thread Quality by Differential Gaging—July p. 66
Jones, Ernest—Saw Brushes*, Jan. p. 84
Clamp Screw Adapter*, Feb. p. 79
Drill Gage*, Apr. p. 87
Tubing Punch*, May p. 85
Thread Flattener*, June 15 p. 80
Vise Pads Facilitate Setup, July p. 43
Scribing Method*, Aug. p. 39

Jones, Ernest (Continued)
Finder for Fast Centering—Sept. p. 87
Vise Parallels*, Oct. p. 76
Cutoff and Groove Rolling Die*, Dec. p. 45
Jones, W. E.—Quality Control Applications in the Job Shop, Apr. p. 334

—K—

Kahat, Frank W. and Charles H. Good—Stylii and Roughness Measurement*, Sept. p. 257
Kececioglu, Dimitri and Arthur Sorensen, Jr.—Coolant Performance Compared—Mist, Flood, Air, Nov. p. 101
Kendrick, G. A.—Tool Lifting Device*, June p. 82
Kiernan, C. E. and P. E. Roggi—Vinyl-Clad Metals*, Sept. p. 257
Kloote, George—Treated Wood Proved Dimensionally Stable, Jan. p. 113
Krabacher, E. J. and Marko Paliobagis—Radioisotope Study of Tool Wear*, Nov. p. 225
Kramer, Leonard—Long-Range Manufacturing Planning—Crystal Ball or Computer? June 15 p. 73
Krueck, Robert and Norman Zlatin—Milling High-Strength Alloys, May p. 123
Krueck, R. T. and R. L. Vaughn—Recent Developments in Ultrahigh-Speed Machining, Apr. p. 95
Kutschera, Paul W.—Progressive Forming Die, June p. 80
Kuzmick, Jerome F. and Glenn B. Goodfellow—Bonding Carbide to Steel*, Aug. p. 143

—L—

Lancaster, Errol J.—An Organized Approach to Reliability*, Apr. p. 335
LaRue, Arthur J.—Improving Reliability of Automatic Assembly Operations, May p. 119
Lazan, B. J.—Material and Structural Damping for Vibration Control*, June p. 211
Levy, Alan V.—Elevated Temperature Testing of Flight Vehicle Materials*, Apr. p. 333
Linsell, L. L. and H. A. Bachman—Cast-to-Size Dies Prove Economical, Jan. p. 111
Ludwig, Richard—Forming Titanium with Resistance Heated Dies, Mar. p. 107
Lynas, R. M.—Controlling Manufacturing Costs*, Aug. p. 143

—M—

Mankonen, Harry E.—Constant-Force Springs—Controlled Force for Production, Nov. p. 117
Masser, William J.—Qualith Control Engineering in New Design*, Apr. p. 335
Mazar, William S.—Deep Hole Drilling Fixtures*, Sept. p. 88
Mehalek, J.—Quality Control with Audit Systems*, Apr. p. 329
Mehl, C. L., W. Pentland and J. L. Wenneberg—High-Temperature Machining, Nov. p. 92
Mellinger, Ernest F. and Floyd A. Cox—Explosive Forming*, July p. 141
Mennell, Roy—How To Get Optimum Production from Multiple Machine Setups, July p. 81
Merchant, M. Eugene—Future Trends in Materials Removal Techniques*, Aug. p. 144
Michelson, Leonard C.—Electronics and Machine Tools*, Aug. p. 143
Minturn, C. B.—Electrical Discharge Machining*, Aug. p. 147
Mittenberg, A. A.—Inspecting Taper Threads*, Sept. p. 259
Monroe, Harry—Machinery Maintenance, Apr. p. 329
Moody, J. C.—How Temperature Affects the Measurement of Aluminum, Feb. p. 81
Murray, Frank—Ratchet Mechanism*, Jan. p. 81
Plier Holding Method*, Mar. p. 77
Quick-Acting Work Driver*, June 15 p. 82
Hookbolt Tie Bar*, Oct. p. 78
Toolholder Is Easily Adjusted*, Nov. p. 79
Horn Die Pierces Opposed Holes*, Dec. p. 46

—Mc—

McCue, Raymond G.—Chemical Milling of Honeycomb Core Blanket, Dec. p. 60
McGee, F. J.—Machining the Unmachinable, Oct. p. 79
McIntosh, John—Revising Plant Layouts*, Sept. p. 257
McLaughlin, Clint—Punch Fitting Method*, Feb. p. 77
Keyway Gage*, June 15 p. 80
Magnetic Chuck Block, July p. 44
Plastics Grid Gage, Sept. p. 90

*Brief article less than 1 page.

—N—

Nara, Harry R., D. K. Wright, Jr. and Charles W. Briggs—Comparison of Steel Castings and Weldments*, Sept. p. 261
Neuweiler, N. G.—Tool Engineering in Russia—The Long-Range Plan, Feb. p. 73
Noll, Howard C.—Increasing Tap Life, Aug. p. 76
Novy, Russell F.—Steam Treatment Improves Cutting Tool Performance, June 15 p. 92

—O—

Ostendorf, Edward H.—Automatic Operation Simplifies Cable Manufacture, June p. 115

—P—

Paliobagis, Marko and E. J. Krabacher—Radioisotope Study of Tool Wear*, Nov. p. 225
Parker, Leo T.—Carbide Boring Bar Halves Machining Time, Jan. p. 98
Parr, J. Frederick—Welding Developments—New Tools for Production, Jan. p. 115
Hydrospark Forming Shapes Space-Age Metals, Mar. p. 81
Pedersen, R. and S. L. Rice—Gear Failure*, Oct. p. 199
Pendleton, J. S., Jr.—How To Cut Tool and Die Costs—Part 1—Oct. p. 116
How To Cut Tool and Die Costs—Part 2, Nov. p. 110
How To Cut Tool and Die Costs—Part 3, Dec. p. 49
Pentland, W., J. L. Wennberg and C. L. Mehl—High-Temperature Machining, Nov. p. 92
Perina, H.—Punch Grinding Fixtures*, Aug. p. 38
Peterson, John L.—Training Maintenance Apprentices and Supervisors*, Apr. p. 331
Pettigrew, David—Drilling and Tapping Tools*, Apr. p. 90
Pfau, J. H.—Research and Development Techniques in Maintenance*, Apr. p. 339
Pflug, Charles E.—Plant Design*, Aug. p. 147
Pfouts, O. A. and C. F. Jatczak—Welding Renews Damaged Dies, July p. 77
Philipchuk, Vasil—Metal Fabrication by Explosives*, Sept. p. 263
Phillips, Frank—Determining Decarburization Depth—Nondestructively, Oct. p. 119
Powell, Harry R.—Reliability and Design*, Nov. p. 223
Prendergast, John F.—Value Engineering Productivity*, Sept. p. 258
Price, James E.—Improving the Reliability of Ground Parts, Dec. p. 75

—R—

Reeves, Thomas C.—Reliability Prediction*, Oct. p. 195
Reinhardt, Robert W.—Quality Tooling Proves Economical, May p. 99
Remmerswaal, J. L.—Machining Cast Iron with Ceramic Tools, Feb. p. 115
Rice, S. L. and R. Pedersen—Gear Failure*, Oct. p. 199
Roggi, P. E. and C. E. Kiernan—Vinyl-Clad Metals*, Sept. p. 257
Rona, Thomas P.—Selection of Methods and Instruments for Vibration and Shock Testing*, Apr. p. 338
Rooney, Elizabeth R.—Engineer Cuts Surgical Costs, Aug. p. 89
Ropitzky, J. and E. L. Goerold—Modern Machining of Cannon, Nov. p. 107
Rossberger, Frans—Why Use Hand-Operated Tracer Machines? June 15 p. 111
Rosseau, Leon B.—Heat-Treatment of Tools with Salt-Bath Furnaces, May p. 105
Roth, Edward S.—How To Use Positional Tolerances—Part 1, Dec. p. 687
Rudolph, H. G. and C. D. Thayer—Molybdenum Grease*, Oct. p. 199
Rush, Frank L.—Hole Spacing Method*, Jan. p. 82

—S—

Sandberg, Robert A.—Future Trends*, Dec. p. 155
Scerbo, E. and W. Calebaugh—In-process Inspection—A Must in Missile Machining, May p. 109
Schilling, Detlef—Chuck Jaws*, Feb. p. 78
Schlesinger, Klaus L.—Ball-Bearing Follower Rest*, Sept. p. 90
Schmaus, James W.—Glass Testing Jig*, June p. 82
Schmeichel, N. L.—Improving Plant Layouts*, Sept. p. 257
Schmidt, A. O.—Charecteristics and Performance of Ceramic Tools*, July p. 141
Obtaining High Performance from Ceramics and Carbides, Aug. p. 55
Schneider, Fred J.—Self-Centering Device, June p. 79
Schwartz, Mel—Dip Brazing Bonds Missile Metals Efficiently, June 15 p. 87
Sedlik, Harold—Lubricated Follower Rest*, Feb. p. 79
Sharp, Colin—Getting the Most Out of Milling, Nov. p. 75
Shoemaker, John H. and George Bidigare—Nitriding for Wear and Fatigue Resistance*, Oct. p. 195
Smith, David N.—Machine Capability—A Tool for Builder and User*, Apr. p. 336
Smith, S. S. and R. M. Akers—How To Determine Optimum Feeds and Speeds, June p. 105
Sokol, Benjamin—Laminating Process Simplifies Tooling, July p. 39
Sollecito, William E.—Analysis by Analog Computers*, Oct. p. 198
Sorensen, Arthur, Jr. and Dimitri Kececioglu—Coolant Performance Compared—Mist, Flood, Air, Nov. p. 101
Spencer, Henry C.—Safety Circuit Ends Press Injuries, Aug. p. 82
Springer, Vernon E.—Stop for Punch and Shear Machine, June p. 81
Stewart, H. L.—How To Apply Pneumatic Power—Part 1, July p. 50
How To Apply Pneumatic Power—Part 2, Aug. p. 77
How To Apply Pneumatic Power—Part 3, Oct. p. 109
Stone, M. L.—An Anchor Man on the Potomac, July p. 88
The Engineer as a Citizen, Sept. p. 183
"Most Wanted" List for Hall of Tools, Oct. p. 129
Strasser, Federico—Punching Tool*, Jan. p. 84
Double Form and Cutoff Die, July p. 46
Driving Dog*, Sept. p. 89
Telescoping Guide Holds Springs in Place*, Nov. p. 80
Stugard, Carl F.—The Future of Automation, May p. 79
Sun, P. C.—Slide Boring Bar, May p. 88
Hot-Roll Spinning Controls Wall Thickness, Oct. p. 93

—T—

Tangerman, Elmer J.—Creativity, Nov. p. 231
Tarkan, S. and J. L. Ellis—Machinable Carbides Solve Wear Problem, Nov. p. 99
Thayer, C. D. and H. G. Rudolph—Molybdenum Grease*, Oct. p. 199
Thorton, J. F.—Preventive Maintenance Work*, Apr. p. 337
Todd, Kenneth—Centralizing Mechanism*, Apr. p. 89
Tolan, J. H.—Radioisotopes Monitor Machining*, Oct. p. 195
Twitchell, Frank A.—Programming for Contour Milling, Jan. p. 88

—U-V—

Uniechowski, S. R.—Calculating Grinding Wheel Wear and Production, June 15 p. 113
Valencia, S. and P. A. G. Carbonaro—Cold Swaging Extends Design Horizons, Apr. p. 113
Vaughn, R. L. and R. T. Krueck—Recent Developments In Ultrahigh-Speed Machining, Apr. p. 95
Vogt, Werner—Developing Cam System Charts for Optimum Performance, Mar. p. 115

—W—

Wagner, H. J. and J. G. Dunleavy—Hydrospark Forming—Evolution of the Process, Mar. p. 83
Walker, Donald—Rolling and Peening Produces Smooth Finishes, Feb. p. 105
Warrick, Leland K.—Increased Use of Plastics*, Sept. p. 259
Watson, E. C.—Adjustable Speed Drives*, Aug. p. 147
Watts, A. Frank and Dorsie C. Harleman—Why Form Explosively? Apr. p. 109
Webber, George B.—Gage Block for Measuring Millionths, Nov. p. 83
Welte, B.—Hydraulic Spindle Drives*, Nov. p. 223
Wennberg, J. L., C. L. Mehl and W. Pentland—High-Temperature Machining, Nov. p. 92
Williams, Lynn A.—Electrolytic Machining*, Aug. p. 143
Witzke, Fred W.—Putting Electronic Gages to Work, May p. 93
Wolfram, L. F.—Flash Welding, Mechanization, Speed Drill Pipe Production, Mar. p. 89
Wood, William W.—High-Energy Forming Methods—A Critical Review, June 15 p. 93
Wright, D. K., Jr., Harry R. Nara and Charles W. Briggs—Comparision of Steel Castings and Weldments*, Sept. p. 261

—Y-Z—

Young, Arnold W.—Please Define, Oct. p. 73
Zagar, Frank—Drilling Holes to Size—in One Operation, Dec. p. 65
Zimmer, Harry E. and J. E. Epprecht—Processing, Aug. p. 67
Zimmerman, W. E.—Extrusion Hobbing Forms Intricate Cavities, Aug. p. 41
Zlatin, Norman and Robert Krueck—Milling High-Strength Alloys, May p. 123

1960 SUBJECT INDEX

—A—

Ablation materials*, Jan. p. 202
Abrasive*, Dec. p. 153
  belt finishing, Sept. p. 82
  metal removal, Sept. p. 112
  wheels, June 15 p. 113
Abrasives, Oct. p. 83
Accelerator, Proton, Dec. p. 37
Accuracy
  grinding, Sept. p. 113
  machine, July p. 76
Adapter, clamp screw*, Feb. p. 79
Adhesive coating, Dec. p. 44
Adiabatic shear, Apr. p. 98
Adjustable die*, Sept. p. 106
Adjustable stop*, Mar. p. 79
Air coolant, Nov. p. 101
Aircraft
  drills, Apr. p. 101
  fasteners*, Feb. p. 202
Airless shot-blasting machine, Mar. p. 91
Alignment telescope, July p. 76
Alloys
  cobalt-base, May p. 128
  high-strength, Nov. p. 92
  milling high-strength, May p. 123
  nickel-base, May p. 126
  ultrastrength*, Jan. p. 199
Aluminum
  impact extrusion*, Feb. p. 89
  measurement of, Feb. p. 81
  oxide wheels, Dec. p. 76
  soldering, Nov. p. 121
  welding, Jan. p. 120; Oct. p. 105*
Angle deviation, threads, July p. 69
Angular measurement, Oct. p. 74
Annealing before hardening, Dec. p. 49
Anode manufacturing, Aug. p. 41
Arbor, hydraulic*, June 15 p. 82
Arbors, splined milling, Sept. p. 108
Arc heating, Nov. p. 97
Arc plasma, Jan. p. 116; Oct. p. 197*
Argon, welding, Jan. p. 118
Artery clamp, June p. 78
Asbestos, use in machining, Nov. p. 96
Assembly, automatic, May p. 114*; May p. 119; May p. 122
  failures in, May p. 121
  fixture, Nov. p. 90
  gear, Aug. p. 50
  lines, Apr. p. 73
  lines, progressive, Aug. p. 49
  machines, Apr. p. 80
  small parts*, Mar. p. 112
Atomic
  Beam devices*, Dec. p. 66
  Energy Commission, Dec. p. 37
  structure, Dec. p. 37
Austenitic stainless steel, May p. 124
Austenitic welding rods, July p. 80
Automated short-run production, Apr. p. 83
Automatic
  assembly, May p. 119; May p. 122*, June 15 p. 91*
  broaching, Aug. p. 52
  drill machine*, Feb. p. 92
  gage control*, June p. 114
  gaging and sorting*, Jan. p. 203
  grinding machine, Aug. p. 51
  loading device*, Mar. p. 99
  machining*, Dec. p. 73
  operation, June p. 115
  seam welder, Aug. p. 47
  threading, Sept. p. 82
Automation, Jan. p. 77; May p. 79; June p. 115; Oct. p. 88; Oct. p. 109
  fixed program, May p. 81
  forging, Feb. p. 96
  industrial*, July p. 141
  press, Sept. p. 122
  selectable program, May p. 82
Automotive
  assembly, Feb. p. 111; Mar. p. 114
  tooling, Apr. p. 73
  trim, welding*, Dec. p. 58
  welding, Apr. p. 74
Auxiliary jigs, Oct. p. 102

—B—

Balancing grinding wheels, Oct. p. 95
Band-sawing costs, Oct. p. 114
Barrel boring*, Feb. p. 113
Bar stock, weight calculation, Mar. p. 95
Bar stock, whip, May p. 89

*Brief article less than 1 page.

Bars and billets, packaging*, Oct. p. 108
Bearing grinder, Jan. p. 96
Bearing-race inspection, Dec. p. 63
Bearingizing, Feb. p. 105
Bearings, grinding, Sept. p. 113
Belt drives, June p. 90
Belt grinding, Dec. p. 79
Bending fixtures*, Sept. p. 88
Beryllium fasteners*, Jan. p. 87
Beryllium welding, Jan. p. 116
Billet shear, Jan. p. 93
Blank preparation, hobbing, Aug. p. 43
Blast furnaces*, July p. 84
Blasting, deburring*, Oct. p. 107
Blind drilling, feedback signal, Mar. p. 105
Boilermaker machine, June p. 110
Bonding carbide to steel*, Aug. p. 143
Bonding, metal, June 15 p. 87
Borescope, July p. 41
Boring, June 15 p. 108; Sept. p. 91
  machine*, Oct. p. 80
  numerically controlled*, Nov. p. 91
  operations, Jan. p. 82*; Dec. p. 73
Boring bar
  carbide, Jan. p. 98
  deflection, Jan. p. 99
  slide, May p. 88
Brake, trolley*, Feb. p. 79
Brazing*, Oct. p. 197
  dip, June 15 p. 87
Breakage assembly*, May p. 122
Broaching, Jan. p. 77; Feb. p. 133*; Oct. p. 91*
  automatic, Aug. p. 52
  cylinder blocks*, June p. 112
  machine, Feb. p. 92*; Oct. p. 91*
Bromobenzene, Mar. p. 84
Buffing lathes*, Dec. p. 56
Building blocks, Mar. p. 87
  automation, Jan. p. 77
  construction, May p. 82
Burr formation, Dec. p. 42
Business simulation, June 15, p. 73

—C—

Cable Manufacture, June p. 115
Calculation, weight, bar stock, Mar. p. 95
Cam
  behavior, Mar. p. 117
  curves, Dec. p. 81
  layout, Mar. p. 116
  system charts, Mar. p. 115
  systems, Mar. p. 115
Cams
  circular-arc, Mar. p. 116
  harmonic, Dec. p. 81
  machining, Sept. p. 85
  simple harmonic, Mar. p. 116
  straight-line, Mar. p. 116
Carbide
  boring bar, Jan. p. 98
  chipbreaker, June p. 85
  cutters, Nov. p. 77
  cutting tools, Sept. p. 81; Sept. p. 97
  forming tools*, Feb. p. 191
  inserts, Jan. p. 99
  milling cutters, May p. 123
  reinforcing strips, Jan. p. 100
  toolholder, Jan. p. 98
  tooling, Aug. p. 55
  tools, Dec. p. 153
Carbides, Oct. p. 79
  machinable, Nov. p. 99
  versus ceramics, Feb. p. 116
Carbonyl nickel, June p. 101
Carburization, excessive, Dec. p. 50
Cartesian dimensioning, Dec. p. 53
Casings and die shells, tool steel*, Apr. p. 119
Cast iron, machining, Feb. p. 115
Cast-face dies, Feb. p. 99
Cast-to-size dies, Jan. p. 111
Casting
  flame cutting, June p. 85
  layout, Feb. p. 103
  machining*, Dec. p. 74
  quality, June p. 84
  techniques, Jan. p. 111
Castings
  cast-to-size, Jan. p. 111
  inspection, Dec. p. 64
  machining steel, June p. 84
  structural*, Mar. p. 200
Cavities, extrusion hobbing of, Aug. p. 41
Center drilling operations*, Mar. p. 99
Center finder, Sept. p. 87
Center, special*, Mar. p. 77
Centering device, June p. 79
Centralising mechanism*, Apr. p. 89

Ceramic cutting tools, Feb. p. 115; Mar. p. 195*; July p. 141*; Aug. p. 55; Aug. p. 137; Sept. p. 97; Oct. p. 192*
Ceramics versus carbides, Feb. p. 116
Chambering and rifling, Apr. p. 115
Charpy tests, June 15 p. 96
Charts
  cam system, Mar. p. 115
  diameter, Aug. p. 72
  spring selection, Jan. p. 101
Chatter, grinding, Oct. p. 99
Chemical milling, Dec. p. 60
Chip
  disposal, Sept. p. 101
  formation, Feb. p. 192*; Mar. p. 101; Apr. p. 98; Aug. p. 61; Aug. p. 83
  separators, magnetic, June p. 90
  thickness ratio, Aug. p. 56
  thickness shear angle, Aug. p. 56
  tool contact, Aug. p. 56
Chipbreaker, carbide, June p. 85
Chlorine, welding in, Jan. p. 121
Chromate, zinc, July p. 39
Chromium carbide, Nov. p. 84
Chuck jaws*, Feb. p. 78
Chucks, rigidity of, Jan. p. 188
Circuit
  breakers, manufacture, Aug. p. 45
  cutoff, July p. 53
  machining, July p. 54
  pressure test, Oct. p. 111
  safety, July p. 53; Aug. p. 82
  staking, July p. 51
Circuits
  electric pneumatic, Aug. p. 77
  multipurpose, Oct. p. 110
  pneumatic, July p. 50
  pneumatic power, Oct. p. 109
  work-handling, Aug. p. 77
Circular-arc cams, Mar. p. 116
Clamp screw adapter*, Feb. p. 79
Clorecon process, Jan. p. 121
Clutches, electromagnetic, May p. 104
CO_2 welding, Jan. p. 118
Cold forming, Feb. p. 95
Cold swaging, Apr. p. 113
Columbium, grinding, Oct. p. 121
Combination clamp*, Jan. p. 82
Combined operations, Feb. p. 87
Communications, Oct. p. 73
  industrial, Mar. p. 75
Comparator gage heads, May p. 94
Competition, foreign, Sept. p. 79
Compression loads, spring, Jan. p. 101
Computation chart, machining, June p. 107
Computer manufacturer*, Jan. p. 108
Computers, June 15 p. 73; July p. 84*; Aug. p. 144*; Oct. p. 85; Nov. p. 86; Dec. p. 52
  analog*, Oct. p. 198
  digital, Dec. p. 155
  gaging in, June p. 92
  uses of, May p. 83
Continuous-path control, Jan. p. 89
Contour
  grinding, May p. 101
  machining, standardization, July p. 65
  milling, Jan. p. 88
  turning*, Oct. p. 106
Contouring, precision, Sept. p. 117
Control
  continuous path, Jan. p. 89; Sept. p. 94
  flow, July p. 53
  production, Apr. p. 73
  quality, Apr. p. 76; Apr. p. 329*
  systems, Sept. p. 97; Sept. p. 101
Controlled
  furnace atmospheres, June 15 p. 92
  temperature furnace, June 15 p. 109
  welding*, Aug. p. 53
Controls
  electrical, Aug. p. 81
  lathe, Sept. p. 92
  pilot, Aug. p. 81
  press, Aug. p. 82
Conversion attachment, surface grinder, Mar. p. 97
Conveyors, Aug. p. 54
Coolants
  abrasive belt grinding, Dec. p. 80
  compared, Nov. p. 101
  drilling effects of, Apr. p. 101
  milling, Nov. p. 77
  systems, gun-drilling, June p. 90
  testing, Nov. p. 102
Copying device*, Aug. p. 139
Costs
  reduction, Feb. p. 87; Mar. p. 203*
  tool and die, Oct. p. 116

Countersinking, die design, Aug. p. 36
Couple unbalance, Jan. p. 109
Crankshaft grinder*, June p. 112
Creative engineers*, July p. 55
Creep, June 15 p. 97
  forming, Mar. p. 107
Critical speeds, bar stock, May p. 90
Curve, sinusoidal, Oct. p. 75
Curved surfaces, machining, Dec. p. 54
Curvic coupling grinder, Sept. p. 82
Cutoff circuit, July p. 53
Cutoff wheels, silicone carbide, Oct. p. 79
Cutter geometry, Nov. p. 76
Cutter trajectories*, Feb. p. 198
Cutters
  grinding, Jan. p. 94
  milling, July p. 85; Nov. p. 75
Cutting
  angles, Feb. p. 119
  energy, specific, Aug. p. 58
  force, analysis, Mar. p. 101
  forces, measurement*, Feb. p. 192
Cutting fluids, see also coolants
  cutting fluids, June p. 207
Cutting force*, Dec. p. 153
Cutting speeds, Sept. p. 95
Cutting tools, Apr. p. 97; June 15 p. 92
  ceramic, Feb. p. 115
  cutting conditions, Aug. p. 55
  forces, Aug. p. 56
  modern, Sept. p. 97
  performance, Nov. p. 102
  shear stress, Aug. p. 58
Cycle programmer, Jan. p. 89
Cylindrical grinder, flat surfaces*, Nov. p. 91
Cylindrical grinding, Mar. p. 97

—D—

Data sheets, cam design, Dec. p. 82
Deburring, June 15 p. 107; Oct. p. 107*
Decarburization, Nov. p. 112
  depth, Oct. p. 119
  excessive, Dec. p. 50
Deep drawing, June 15 p. 105
Deep-hole drilling, Sept. p. 100
Deflection, boring bar, Jan. p. 99
Deflection, spring, Jan. p. 101
Deformation process*, Mar. p. 199
Deformation, tool and die, Oct. p. 118
Depreciation legislation, May p. 213
Depth gage*, Feb. p. 77
Design
  automotive parts*, Jan. p. 202
  broach, Jan. p. 78
  criteria, reliability*, Mar. p. 200
  hot-air frame*, Mar. p. 201
  industrial equipment*, May p. 214
  plant*, Aug. p. 147
  pneumatic circuits, July p. 50
  practice, Dec. p. 49
  reliability*, Feb. p. 199
  resistance-heated dies, Mar. p. 108
Determining decarburization depth, Oct. p. 119
Deviations, thread, July p. 68
Diameter charts, Aug. p. 72
Diamond grinding wheels, Oct. p. 83
Diamonds, synthetic*, Dec. p. 153
Dictionary, engineer's*, May p. 215
Die
  adjustable*, Sept. p. 106
  construction, Jan. p. 112
  design, Dec. p. 41
  double-form, cutoff, July p. 46
  drawing*, Feb. p. 80
  forming and bending*, Jan. p. 83
  life, improved forging, Feb. p. 95
  loading, Sept. p. 119
  manufacture, June p. 101
  progressive forming, June p. 80
  steel, drilling, Apr. p. 104
  steel, swaging, Apr. p. 114
  steels, Jan. p. 189
  U-bend and form*, May p. 85
Die Design, Sept. p. 120; Oct. p. 78*; Nov. p. 88; Nov. p. 111
  extrusion, Aug. p. 42
  swaging, Apr. p. 116
Diemaking, June p. 101; June 15 p. 111
Dies
  cast-to-size, Jan. p. 111
  epoxy, Feb. p. 97
  forging, Feb. p. 94
  integrally heated, June 15 p. 102
  machining, June 15 p. 111
  materials, Feb. p. 98
  nitriding, Feb. p. 95
  resistance heated, Mar. p. 107
  swaging, Apr. p. 114
  welding, July p. 77
Diethylenetriamine, July p. 40
Differential gaging, May p. 96; July p. 66
Diodes, tunnel*, June p. 95
Dip brazing, June 15 p. 87
Dip-transfer process, Jan. p. 119
Dissimilar materials, swaging, Apr. p. 116
Dog, driving*, Sept. p. 89
Drabkina formula, Mar. p. 85
Drawing
  die*, Feb. p. 80
  glass*, Oct. p. 92
  operations, press, Sept. p. 121
  temperatures, effect, Nov. p. 112
Dresser, grinding wheel, June 15 p. 90
Drill
  attachment*, Nov. p. 79
Drill (Continued)
  body eccentricity, June 15 p. 83
  gage*, Apr. p. 87
  jig, universal*, June p. 83
  life, Apr. p. 102
  pipe, production, Mar. p. 89
  point eccentricities, June 15 p. 83
  portable, Oct. p. 77
  press, overhead*, Mar. p. 112
  stand, Mar. p. 80
  symmetry, June 15 p. 83
Drilling*, Mar. p. 113; Dec. p. 72*
  circuit boards*, July p. 72
  deep holes, June p. 89; Sept. p. 100
  fixture, Aug. p. 40*; Sept. p. 88*
  numerically controlled, Sept. p. 101
  operations, Jan. p. 80*, Mar. p. 105; Apr. p. 120*
  operations, automatic, June p. 100
  production*, Apr. p. 104
  stubs*, Apr. p. 104
  tapping tools, and*, Apr. p. 90
  techniques, gun, June p. 89
  tests, Nov. p. 96
  titanium, Aug. p. 83
  tungsten, Oct. p. 80
Drilling machine, Sept. p. 104; Oct. p. 92*
  numerically controlled, Sept. p. 100
Drills
  aircraft, Apr. p. 101
  carbide-tipped, Nov. p. 96
  chipbreaker, Sept. p. 126
  cobalt high-speed, Nov. p. 96
  high-speed, Apr. p. 101
  special twist*, Sept. p. 251
  step, Dec. p. 65
Driver, work*, June 15 p. 82
Driving dog*, Sept. p. 89
Drives, Sept. p. 95
  adjustable speed*, Aug. p. 147
  machine, Sept. p. 98
  milling machine*, Sept. p. 251
Ductile metals, turning*, May p. 215
Duplex taper mandrel, June 15 p. 81
Dynamic unbalance, Jan. p. 109

—E—

Economics, employment, June p. 76
Econoweld process, Jan. p. 121
Education, engineering, Jan. p. 198*; Feb. p. 201*
Elasticity, effect on measurement, Feb. p. 84
Electric-beam welding, Jan. p. 115
Electrical discharge machining, Mar. p. 83; June 15, p. 91*; Aug. p. 147*; Dec. p. 72
Electro-acoustical energy, Mar. p. 84
Electrocontact machining*, Dec. p. 153
Electrohydraulic forming, Mar. p. 81; Mar. p. 83; July p. 142*
Electrolytic machining*, Aug. p. 143
Electrode, rotating*, Dec. p. 58
Electrodes, welding, July p. 78
Electroforming, June p. 102
Electromagnetic forces, machining with, Apr. p. 96
Electromolding, Jan. p. 118
Electron-beam machining*, Mar. p. 104
Electron generator, high-voltage*, June p. 111
Electronic drives*, Dec. p. 153
Electronic gages, May p. 93; June p. 91
Electronics*, Aug. p. 143
Electroslag welding, Jan. p. 117
Employment, economics of, June p. 76
Engineering
  education, Jan. p. 198*; Feb. p. 201*
  enrollment*, June 15 p. 110
Epoxy
  dies, Feb. p. 97
  dies, construction, Feb. p. 99
  manufacturing anode, use in, Aug. p. 44
  resin, hardness, Feb. p. 102
  shedder*, Oct. p. 78
  thixotropic, July p. 42
Estimating costs, band-sawing, Oct. p. 114
Exotics materials, machining, June p. 84
Expanding mandrel*, Apr. p. 90
Explosive forming, Feb. p. 97; Apr. p. 109; June 15 p. 93; July p. 141*
  tooling, Apr. p. 112
Explosives, metal fabrication*, Sept. p. 263
Extrusion hobbing, Aug. p. 41

—F—

Face milling, Nov. p. 77
Fasteners
  beryllium*, Jan. p. 87
  self-broaching*, May p. 92
  tightening, Nov. p. 90
  torque*, July p. 139
Fastening devices*, Dec. p. 70
Fatigue
  analysis*, Feb. p. 202
  resistance*, Oct. p. 195
  strength, metals, Oct. p. 113
Feed mechanisms, Sept. p. 99
Feed rates, Dec. p. 54
Feedback signal, blind drilling, Mar. p. 105
Feeder, parts*, Sept. p. 89
Feeds and speeds, Nov. p. 75
  determination of, June p. 105
Fillet welding, June 15 p. 120
Finish, grinding, Sept. p. 113
Finishing, abrasive belt, Sept. p. 82
Fitting method, punch*, Feb. p. 77
Fixed-program automation, May p. 81
Fixture
  drill, Oct. p. 116
Fixture (Continued)
  drilling, Aug. p. 40*; Sept. p. 88*
  grinding, Dec. p. 43
  lathe*, Aug. p. 39
  punch grinding*, Aug. p. 38
  shuttle tapping*, Sept. p. 103
Fixtures
  bending*, Sept. p. 88
  missile, May p. 109
  welding, Apr. p. 74
Fixturing, gun drilling, June p. 90
Flame cutter*, Mar. p. 99
Flame heating, Nov. p. 97
Flanging tool*, Nov. p. 78
Flash welding, Mar. p. 89
Flatness, machine tool, Sept. p. 82
Flattening furnace*, Feb. p. 91
Flood coolant, Nov. p. 101
Flow control, July p. 53
Fluid-level controls*, Oct. p. 82
Foil-seam welding, Jan. p. 123
Foil, structural*, Jan. p. 203
Follower cam, reciprocating, Dec. p. 81
Follower rest*, Sept. p. 90
  lubricated*, Feb. p. 78
Forces causing stock whip, May p. 89
Forging
  aluminum*, June p. 113
  costs, Feb. p. 94
  lead and aluminum*, Mar. p. 203
Formability, June 15 p. 103
Forming
  creep, Mar. p. 107
  effects of temperature, June 15 p. 102
  electric-discharge, June 15 p. 93
  electrohydraulic*, July p. 142
  explosive, Feb. p. 97; Apr. p. 109
  explosive gas, June 15 p. 102
  high-energy, June 15 p. 93
  high-energy rate*, Sept. p. 262
  high-velocity systems, June 15 p. 101
  hot-fluid, June 15, p. 93
  hydrospark, Mar. p. 81; Mar. p. 83; June 15 p. 93
  induced energy, June 15 p. 93
  plastic flow, June 15 p. 99
  pressure, June 15 p. 101
  superalloys, June 15 p. 105
  temperature dependance, June 15, p. 97
  titanium, Mar. p. 107
  tools, carbide*, Feb. p. 191
  yuttrium metal*, Jan. p. 200
Fortran, Nov. p. 86
Flush quenching, Nov. p. 113
Fracture patterns*, Aug. p. 143
Friction, power losses*, July p. 139
Friction soldering, Nov. p. 122
Fuel cell technology*, Nov. p. 106
Furnace circulation, Dec. p. 51
Furnace, sheet flattening*, Feb. p. 91
Furnaces, salt-bath, May p. 105

—G—

Gage
  combination trepan*, Apr. p. 87
  control, automatic*, June p. 114
  depth*, Feb. p. 77
  drill*, Apr. p. 87
  electronic, May p. 93
  heads, May p. 93; June p. 91
  keyway*, June 15 p. 80
  multipiece*, Apr. p. 89
  multiple*, Oct. p. 76
  plastic grid*, Sept. p. 90
  roundness, May p. 98
  trepan grooves*, Feb. p. 80
Gage blocks, Nov. p. 81
  stability, July p. 75
Gaging, see also Inspection
  automatic, Jan. p. 203*; Apr. p. 79
  differential, July p. 66
  master bar, June p. 91
  movement, Aug. p. 38
  numerically controlled, June p. 91
  operations, July p. 70
  strip, Dec. p. 79
Gallium arsenide*, June p. 95
Gas deposition process, June p. 101
Gases, plasma-flame, Apr. p. 106
Gear
  assembly, Aug. p. 50
  failures*, Oct. p. 199
  manufacture, Feb. p. 89
  position, error control*, Feb. p. 200
  production, May p. 99
Gear-cutting machines*, Feb. p. 190
Gear-shaving machine, Sept. p. 102
Geared rifling, Nov. p. 108
Gearing rocket*, Mar. p. 201
Gears
  helix form*, Mar. p. 201
  quick-change, Aug. p. 40
  spiral-bevel, cutting*, Feb. p. 191
Geometry
  cam, Dec. p. 84
  cutter, Nov. p. 76
  master gage, June p. 92
Gimbal, machining of, May p. 109
Glass-testing jig*, June p. 82
Graduation machine, Apr. p. 88
Granular embedment, Feb. p. 99
Graphical solution of production rates, July p. 83
Graphite, colloidal*, Dec. p. 74
Graphitic steel, July p. 77
Grease, molybdenum*, Oct. p. 199
Grinder
  centerless*, Mar. p. 200
  curvic coupling, Sept. p. 82

*Brief article less than 1 page.

Grinder (Continued)
high-production, Sept. p. 82
turbine blade, Nov. p. 118
Grinding, June 15 p. 89; Sept. p. 112; Dec. p. 57*; Dec. p. 75
abrasive-belt, Dec. p. 79
cutters, Jan. p. 94
fixture, Dec. p. 43
induced stress, Dec. p. 75
internal thread, Sept. p. 114
space-age materials, Oct. p. 121
temperatures*, Sept. p. 252
templates, Sept. p. 118
vertical, Aug. p. 62
vibrations*, Oct. p. 191
Grinding wheel
balancing, Oct. p. 95
consistency, Dec. p. 75
dresser, June 15 p. 90
production, June 15 p. 113
strength*, Aug. p. 137
testing, Oct. p 84
vibration, Oct. p. 95
wear, June 15 p. 113
unbalance, Jan. p. 109
Grinding wheels
diamond, Feb. p. 204*; Oct. p. 83; Oct. p. 121
silicon carbide, June p. 177*; Oct. p. 121
Gun
boring, June p. 89
drilling, June p. 89
reamers, July p. 47
reaming, June p. 89; July p. 47

—H—

HCHC steels, Dec. p. 51
Hafnium welding, Jan. p. 116
Handicapped, tooling for the, June p. 71
Hardness, bearingized surfaces, Feb. p. 105
Harmonic cams, Dec. p. 81
Harmonic curve, Dec. p. 81
Heat treat, controlled-atmosphere, Oct. p. 118
Heat-treat failure, Dec. p. 49
Heat treatment*, Feb. p. 114
anodes, Aug. p. 44
drawing temperature, Oct. p. 118
effects of, Nov. p. 111
tool and die, Oct. p. 118
tools, May p. 105
Heating methods, hot machining, Nov. p. 96
Helix tools, machining*, Oct. p. 191
High-energy forming, June 15 p. 93
High-energy-rate forming, Feb. p. 97
High-production job shops, Aug. p. 45
High-speed drills, Apr. p. 101
High-speed steel*, Oct. p. 197
High-strength materials, drilling, Apr. p. 101
High-temperature materials*, Feb. p. 198
Hinged sine bar, July p. 45
Hob design, Aug. p. 42
Hob maintenance, Aug. p. 43
Hobbing, Aug. p. 66
anodes, Aug. p. 43
lubricant, Aug. p. 43
Hole
drilling, Dec. p. 65
production, June 15 p. 83
punching tool*, Jan. p. 84
sizing, Feb. p. 105
Holes—sizing in progressive dies, Aug. p. 35
Honeycomb
core blanket, Dec. p. 60
panels*, Jan. p. 197
sawing, May p. 102
stainless steel*, May p. 115
Honing*, Dec. p. 153
Honing cutting tools, June p. 87
Hot air frame design*, Mar. p. 201
Hot machining*, Dec. p. 153
Hot-roll spinning, Oct. p. 93
Hot upsetting, Dec. p. 51
Hydraulic arbor*, June 15 p. 82
Hydrospark forming, Mar. p. 81; Mar. p. 83
Hydrospark work hardening, Mar. p. 85
Hydrostatic pressure, June 15 p. 97

—I—

Impact
behavior, June 15 p. 96
extrusion*, Feb. p. 89
Impreg, Jan. p. 114
Incentives, production, Sept. p. 81
Indications, Dec. p. 61
Indicators electronic, May p. 93
Induced sound waves, June 15 p. 96
Induced vibration, grinding wheels, Oct. p. 98
Induction heating, Nov. p. 97
Industrial communications, Mar. p. 75
Industry, Red China, in*, Aug. p. 138
Inert-gas welding, Jan. p. 118
Innovation and obsolescence*, Sept. p. 257
In-process inspection, May p. 109
Input analysis, electronic gaging, May p. 95
Insert tooling, June p. 85; June p. 109; June p. 114*; Sept. p. 97; Nov. p. 94
Inspection, see also Gaging, Dec. p. 61
automotive, Apr. p. 76
bearing race, Dec. p. 63
complex machine surfaces, June p. 91
in-process, May p. 109
hot-acid, Dec. p. 50
numerically controlled, June p. 91; Nov. p. 116*
Inspection (Continued)
paper threads*, Sept. p. 259
stampings*, Oct. p. 89
systems, 6-coordinate, June p. 91
T. V.*, Aug. p. 64
tool, Nov. p. 84
Integrally heated dies, June 15 p. 102
Interferometers, Oct. p. 74
Inventory control, June 15 p. 74

—J—

Jig boring*, Dec. p. 153
Jig, glass testing*, June p. 82
Job shops, high-production, Aug. p. 45
Joint design*, Jan. p. 197

—K—

Keyway gage*, June 15 p. 80
Keyway machining*, Feb. p. 112
Kirkwood-Bethe theory, June 15 p. 101
Krypton light, Oct. p. 75

—L—

Labor-cost curve, June p. 108
Laminate construction, July p. 40
Laminate, plastics, July p. 39
Laminate tooling, July p. 39
Laminated dies, Feb. p. 100
Laminated plastics*, May p. 122
Laminates, reinforced*, Mar. p. 199
Lamination dies, Dec. p. 41
Laminating resin, Feb. p. 100
Lathe
constant cutting speed, July p. 58
design, Sept. p. 91
fixture*, Aug. p. 39
operation, Feb. p. 113*; Sept. p. 91
tools, clamped-on*, July p. 139
Layout, cam, Mar. p. 116
Layout, cam design, Dec. p. 83
Layout, plant*, Sept. p. 257
Lever, twin-fulcrum Mar. p. 78
Light, monochromatic, Oct. p. 74
Loader, parts, magnetic, June 15 p. 108
Locators, point-to-point, Jan. p. 89
Lubricants, May p. 113*; Aug. p. 66
metalworking, June p. 207
Lubricated follower rest*, Feb. p. 78
Lubrication, machine*, May p. 215

—M—

Machinability, June p. 177*; Sept. p. 107
ratings, Nov. p. 76
testing*, Sept. p. 251
Machine
accuracy, July p. 76
automatic, May p. 80
automatic grinder, Aug. p. 51
boring, June 15 p. 108
broaching, Jan. p. 78
capability*, Apr. p. 336
chatter, July p. 64
deflection*, Dec. p. 153
design and maintenance, Mar. p. 196
design, safety, Jan. p. 79
drives, Sept. p. 98
graduating, Apr. p. 88
indexing, Jan. p. 77; Nov. p. 89
productivity, June p. 84
settings, drilling titanium, Aug. p. 83
setups, multiple, July p. 81
transfer, July p. 50; July p. 56
vibration, Jan. p. 109
Machine tool
components*, Jan. p. 203
controls*, Feb. p. 190
manufacture, Sept. p. 81
Machine tools, see also specific operation
Machine tools*, Aug. p. 143
future of the, May p. 84
precision, Mar. p. 197
Machinery, stick-slip, July p. 63
Machines
assembly, Apr. p. 80
combination milling and drilling, Aug. p. 48
milling, Sept. p. 107
multiple-hole, Sept. p. 100
numerically controlled, Aug. p. 48
self-regulating, Sept. p. 96
transfer, Apr. p. 78; Apr. p. 92; Apr. p. 93
Machining, see also particular operation
Machining, June p. 107; Oct. p. 79
after welding, Mar. p. 93
aluminum mandrels*, June p. 113
cast iron, Feb. p. 115
castings, Oct. p. 88
circuit, July p. 54
cost*, June p. 109
cost factors, June p. 105
cutting speed, June p. 85
dimensions, Aug. p. 69
electrical discharge, June 15 p. 91*; Aug. p. 147*
electrocontact*, Dec. p. 153
electron beam*, Mar. p. 104
elevated temperature, Nov. p. 92
exotic materials, Sept. p. 95
feeds and speeds, June p. 117
fly-wheel housings, May p. 112
hard materials, Nov. p. 92
helix tools*, Oct. p. 191
hot*, Dec. p. 153
intermittent cuts, June p. 85
memory drum, Oct. p. 85
missile, May p. 109
numerically controlled*, Nov. p. 115
production setups, July p. 81
Machining (Continued)
production tests, June p. 85
punched card, Sept. p. 125
rifle bores, Nov. p. 107
stainless steel*, Nov. p. 115
steel castings, June p. 84
subzero*, Dec. p. 153
surface conditions, June p. 85
tolerances, Aug. p. 70
tools and dies, Oct. p. 116
tungsten, Oct. p. 79
ultrahigh-speed, Apr. p. 95
Magnesium, welding*, Feb. p. 197
Magnetic
chuck block, July p. 44
force welding, Jan. p. 123; Oct. p. 105*
particle testing, Dec. p. 61
powder, Dec. p. 61
Magnets, Dec. p. 37
Mahogany, treated, Jan. p. 113
Maintenance
hob, Aug. p. 43
machine design, and, Mar. p. 196
machinery*, Apr. p. 329
preventive*, Apr. p. 337
techniques in*, Apr. p. 339
training programs*, Apr. p. 331
Mandrel, duplex taper, June 15, p. 81
Mandrel, expanding*, Apr. p. 90
Manufacturing
costs*, Aug. p. 143
explosive forming, Apr. p. 112
processing, Aug. p. 67
Martensitic stainless steel, May p. 124
Mass production, Apr. p. 73
principles, Apr. p. 81
Materials, Feb. p. 198*; Apr. p. 333*; June 15 p. 97
ablation*, Jan. p. 202
Mathematics, geared rifling, Nov. p. 109
Measurement, Mar. p. 202*; Nov. p. 83
standards*, Oct. p. 87
taper, Jan. p. 85
temperature effect on, Feb. p. 81
Mechanical memory device, Mar. p. 96
Mechanical toolholders, June p. 85
Mechanisms, feed, Sept. p. 99
Memory device, mechanical, Mar. p. 96
Memory drums, machining, Oct. p. 85
Merchant theory, Nov p. 92
Mesons, Dec. p. 37
Metal
arc welding, Jan. p. 118
bonding, June 15 p. 87
fabrication by explosives*, Sept. p. 263
fatigue, July p. 73
metallurgical structure, July p. 73
removal, aircraft and missile*, Sept. p. 261
removal rates, Nov. p. 75
spraying, June p. 102
spraying equipment*, June p. 177
structural stress, July p. 74
yttrium*, Jan. p. 200
Metalcutting*, Mar. p. 199
gas, Apr. p. 108
heavy*, Feb. p. 192
problems, Nov. p. 92
Metallizing, Apr. p. 105
torch*, Feb. p. 91
Metals
crystal lattice, July p. 75
deformation, June 15 p. 96
developing stronger, July p. 73
effects of retained austenite, July p. 75
fatigue-strength, July p. 75; Oct. p. 113
hot-spraying of*, June p. 177
impact behavior, June 15 p. 96
plastic deformation, June 15 p. 96
strain-hardening, July p. 75
strength and ductility characteristics, July p. 74
temperature effects, July p. 74
testing*, Jan. p. 197
vinyl-clad*, Sept. p. 257
Metalworking lubricants, June p. 207
Method control, Dec. p. 61
Methodology*, Mar. p. 202
Metric system, kilopond*, Aug. p. 139
Metrology, Oct. p. 73
Micrometer, taper, Jan. p. 85
Micrometers, special-purpose, Jan. p. 86
Mill, Oct. p. 75
Milling, see also Machining; Metalcutting
Milling, Nov. p. 75
chemical, Dec. p. 60
climb, Nov. p. 76
cobalt-base alloys, May p. 128
combined operation, Sept. p. 109
contour, Jan. p. 88
cutters, July p. 85
cutters, carbide, May p. 123
die steel, May p. 127
feeds and speeds, July p. 85; Nov. p. 93
high-strength alloys, May p. 123
machine drives*, Sept. p. 251
machine vibrations*, Sept. p. 251
martensitic low-alloy steel, May p. 124
nickel-base alloys, May p. 128
numerically controlled, May p. 113*; June p. 96
operations, Sept. p. 107
space*, June p. 177
speeds, May p. 123
tests, Nov. p. 95
three-dimensional, June 15 p. 112
tungsten, Oct. p. 81
turning, and, Jan. p. 189
wood*, July p. 139

*Brief article less than 1 page.

SUBJECT 1960 INDEX

Missile, maching, May p. 109
Missiles, transport*, Feb. p. 112
Mist coolant, Nov. p. 101
Mohorovicic discontinuity, May p. 111
Mohr stress circles, June 15 p. 98
Molybdenum, grinding, Oct. p. 121
Molybdenum welding, Jan. p. 116
Monochromatic light, Oct. p. 74
Monorails, overhead, Apr. p. 74
Multipiece gage*, Apr. p. 89
Multiple gage*, Oct. p. 76
Multiple-hole machines, Sept. p. 100
Multiple machine setups, July p. 81

—N—

Nickel, carbonyl, June p. 101
Niobium, grinding, Oct. p. 121
Nitriding*, Oct. p. 195
  forging dies, Feb. p. 95
Nondestructive testing, July p. 72*; Oct. p. 119
Normalizing, stainless-steel dies, Mar. p. 108
Notch geometry, July p. 74
Numerical control, May p. 117; Sept. p. 85; Nov. p. 86
  advantage of, Jan. p. 91
  design*, Apr. p. 329
  drawings, Jan. p. 89
  point location, Jan. p. 90
  programming, Jan. p. 88
  short-run production, Apr. p. 82
Numerically controlled, Dec. p. 52
  boring*, Nov. p. 91
  drilling machines, Sept. p. 100
  grinder, Mar. p. 100
  inspection, June p. 91; Nov. p. 116*
  jig borer, Sept. p. 123
  machines, Aug. p. 48
  machining*, Jan. p. 106
  milling, June p. 96; Sept. p. 109
  pipe bending, June p. 97
  threading, June p. 98

—O—

Obsolescence, May p. 213
  innovation, and*, Sept. p. 257
OD grinding, Mar. p. 98
Oil drilling, Mar. p. 89
Operation sheets, Aug. p. 75
Operator safety, Aug. p. 82
Optical tooling, July p. 76
Organic compound*, Oct. p. 113
Orthogonal turning, Nov. p. 92
Output analysis, electronic gaging, May p. 95
Oxidation, cutting tools, June 15 p. 92

—P—

Packaging bars and billets*, Oct. p. 108
Pantograph, June 15 p. 111
  flame cutter*, Mar. p. 99
Paperwork simplification*, Aug. p. 145
Part positioning, turret lathe*, Nov. p. 78
Parts feeder*, Sept. p. 89
Parts loader*, Dec. p. 57
Patternmaking, June 15 p. 111
Pattern manufacture, June p. 101
Peening, surface finish, Feb. p. 105
Pekelharing phenomenon, Feb. p. 118
Pendant control of machine functions, June p. 98
Phenolic-treated wood, Jan. p. 113
Physical-aid tooling, June p. 72
Pickling, ultrasonic*, June p. 87
Piercing fixture*, Nov. p. 80
Piezoelectric surface testing*, Oct. p. 191
Pipe bending, numerically controlled, June p. 97
Planer mill*, Jan. p. 105
Planing*, Feb. p. 114
Planning
  long-range, June 15 p. 73
  production, in, Apr. p. 74
Plasma flame, Jan. p. 116; Apr. p. 105
Plastic
  deformation in cutting, Nov. p. 94
  deformation in metals, Apr. p. 96
  flow, June 15 p. 99
  grid gage*, Sept. p. 90
Plastics
  increased use*, Sept. p. 259
  laminate, July p. 39
  laminated*, May p. 112
Plating, tungsten, June 15 p. 109
Plier holder*, Mar. p. 77
Plutonium*, May p. 108
Pneumatic circuits, July p. 50
Pneumatic power, July p. 50; Aug. p. 77; Oct. p. 109
Point-to-point locators, Jan. p. 89
Portable drill, Oct. p. 77

*Brief article less than 1 page.

Positioning tolerances, July p. 65
Power controls, Jan. p. 95
Power, pneumatic, July p. 50; Aug. p. 77; Oct. p. 109
Precision boring defects*, Dec. p. 153
Precision contouring, Sept. p. 117
Precision machine tools, Mar. p. 197
Preheating for welding, Mar. p. 91
Preplanned operations, Sept. p. 80
Press
  design, Sept. p. 119
  drives, twin-power, Sept. p. 121
  operations*, May p. 115
  operations, safety, Aug. p. 82
  safety, Sept. p. 122
Pressure angle, cam, Mar. p. 117
Pressure welding, Jan. p. 121
Pressworking, Mar. p. 113*; Apr. p. 120*; June p. 111*
Principles of mass production, Apr. p. 81
Printed circuit boards*, Nov. p. 115
Process control, Dec. p. 153
Process sheets, special, Aug. p. 74
Processing, Aug. p. 67
Product design, Nov. p. 86
Product, machine, June p. 84
Production
  control, Apr. p. 79
  drilling*, Apr. p. 104
  mass, Apr. p. 73
  optimum, July p. 81
  rates, graphical solution, July p. 83
  rifling, Nov. p. 108
  small-lot, Apr. p. 82
Productivity
  engineering*, Sept. p. 258
  planning for, Sept. p. 79
  turret lathe, May p. 117
Profiling, Sept. p. 124
Profit, engineering for*, Jan. p. 197
Programmer, cycle, Jan. p. 89
Programming, Jan. p. 88; Nov. p. 86
  hand, Dec. p. 55
  lathe operations, Sept. p. 92
Progressive die, Aug. p. 35
Progressive forming die, June p. 80
Project evaluation*, July p. 142
Prosthetic tooling, June p. 72
Proton accelerator, Dec. p. 37
Proton synchrotron, Dec. p. 37
Pulleys, magnetic*, Mar. p. 111
Punch
  fitting method*, Feb. p. 77
  grinding fixture*, Aug. p. 38
  tubing*, May p. 85
Punched cards actuate conveyors, Aug. p. 54

—Q—

Quality control, Apr. p. 74; Apr. p. 334*; Apr. p. 335*; Apr. p. 339*
Quenching-action, heat-treat, Dec. p. 51
Quenching, flush, Nov. p. 113
Quick-change gears*, Aug. p. 40

—R—

Radiant heating, Nov. p. 97
Radio frequency resistance heating, Nov. p. 97
Radioisotopes*, Oct. p. 195
Rake angle, double*, Mar. p. 196
Rake angle, influence, Mar. p. 103
Ratchet mechanism*, Jan. p. 81
Reactor, atomic power Apr. p. 118
Reading head, June p. 92
Reamers
  gun, July p. 47
  multidiameter, July p. 48
  multiple flute gun, July p. 47
  spiral-flute, July p. 48
  straight-flute, July p. 48
Reaming, gun, July p. 47
Reaming titanium, Aug. p. 83
Rebuilding transfer lines, Mar. p. 87
Reducing stick slip, July p. 64
Refractory materials, Nov. p. 96
Refractory materials, grinding, Oct. p. 121
Rehabilitation, June p. 72
Reinforcing strips, carbide, Jan. p. 100
Relativity, Law of*, Dec. p. 66
Reliability, Apr. p. 335*; Oct. p. 195*
  assembly, May p. 119
  design criteria*, Mar. p. 200
  ground parts, Dec. p. 75
  tooling, May p. 99
Research sponsored*, Jan. p. 197
Residual stress, Dec. p. 75
Resin, laminating, July p. 39
Resistance heated dies, Mar. p. 107
Retooling, combined operations, Feb. p. 87
Rewind line*, Jan. p. 107
Rework, tooling, Oct. p. 117
Ribbon rifling, Nov. p. 107
Rifle barrel machining*, May p. 114
Rifling Nov. p. 107
  chambering and, Apr. p. 115
Rocket manufacture*, Dec. p. 70
Roll grinding, Jan. p. 109
Rolling, surface finish, Feb. p. 105
Rotary table*, Sept. p. 106
Rotating electrode*, Dec. p. 58
Routing sheet, Aug. p. 71
Russia, tool engineering in, Feb. p. 73
Russian transfer machines*, Apr. p. 307

—S—

Safety
  circuit, July p. 53
  machine design, Jan. p. 79
  press, Sept. p. 122
Salts, heat-treating, characteristics, May p. 105
Salvaging epoxy dies, Feb. p. 102
Sandwich, welded high-temperature*, Jan. p. 108
Satellite tracking system*, Dec. p. 66
Saw brushes*, Jan. p. 84
Sawing honeycomb, May p. 102
Scale removal*, June p. 87
Science for survival*, Feb. p. 197
Screw threads—holding capabilities, July p. 66
Screw threads standards, July p. 66
Scribing blades, Feb. p. 103
Scribing fixture*, Aug. p. 39
Secondary operation, eliminating, Aug. p. 35
Selectable-program automation, May p. 82
Servo mechanisms, July p. 65
Setscrew, orientator, May p. 86
Sewing machine, industrial*, Jan. p. 108
Shaper, automated cycle, July p. 59
Shear, adiabetic, Apr. p. 98
Shedder, epoxy*, Oct. p. 78
Shock, vibration, and*, Feb. p. 198
Shop practice, Oct. p. 116
Shot-blasting machine, airless, Mar. p. 91
Shuttle machine, Jan. p. 97
Shuttle mechanisms, Sept. p. 122
"Silent sentinel", July p. 60
Simple harmonic cams, Mar. p. 116
Simulation, business, June 15 p. 73
Sine bar, Jan. p. 85
Single-point tools, tool life, June p. 117
Sintered iron, machinability*, Aug. p. 143
Sinusoidal curve, Oct. p. 75
Size finder mechanism, Mar. p. 98
Skip welding, July p. 80
Slab milling, Nov. p. 77
Slide boring bar, May p. 88
Slide design, press, Sept. p. 120
Sliding bolsters, Sept. p. 119
Slip planes, June 15 p. 99
Slug cutter, June 15 p. 78
Slugging, Sept. p. 84
Small-lot production, Apr. p. 82
Soaking periods, Nov. p. 113
Soaking time, Oct. p. 118
Soldering aluminum, Nov. p. 121
Soldering, ultrasonic, Nov. p. 122
Sorting, automatic*, Jan. p. 203
Sound waves, induced, June 15 p. 96
Space-Age Materials, machining, Apr. p. 95
Space milling*, June p. 177
Special center*, Mar. p. 77
Specifications, interpretation of, Oct. p. 73
Speed, see Feeds and Speeds
Speeds and feeds, grinding, Dec. p. 76
Spheroidizing treatment*, Feb. p. 114
Spinning*, Aug. p. 64
  aluminum rivets*, Jan. p. 106
  hot-roll, Oct. p. 93
  power*, Mar. p. 200
Spiral milling, Feb. p. 110
Spiral welding, Jan. p. 123
Spotwelder, Apr. p. 91
Spring
  materials, testing*, Feb. p. 86
  positioner*, Nov. p. 80
  production, Dec. p. 59
  selection, Jan. p. 101
Springback, elimination, Feb. p. 98; May p. 115*
Springs, constant-force, Nov. p. 117
Springs, cut from stock lengths, Jan. p. 101
Stainless steel, May p. 124
  casting, Jan. p. 104
  machining, Aug. p. 138*; Nov. p. 76; Nov. p. 115*
  welding*, July p. 70
Staking circuit, July p. 51
Stampings, inspection*, Oct. p. 89
Stampings, square-edge, Nov. p. 88
Standarization*, Mar. p. 199
  contour machining, July p. 65
  forging materials, Feb. p. 94
Standards
  industrial*, Mar. p. 202
  screw thread, July p. 66
  symbols*, Oct. p. 87
Static unbalance, Jan. p. 109
Statistical models*, Apr. p. 329
Statistics, key operating, June 15 p. 74
Steam treatment, June 15 p. 92
  cutting tools, June 15 p. 92
Steel
  air-hardening, Oct. p. 117
  air-tough, Oct. p. 117
  austenitic, May p. 124
  bonded carbides, Nov. p. 99
  castings*, Sept. p. 261
  die, May p. 125
  graphitic, July p. 77
  machining cast, June p. 84
  martensitic, May p. 124
  selection, diemaking, Dec. p. 49

SUBJECT 1960 INDEX

Steel (Continued)
stainless, May p. 124
tool, June 15 p. 106
ultrahigh strength, July p. 73
welding, July p. 78
Steels
high-speed*, Oct. p. 197
oil-hardening, Oct. p. 118
swaging die, Apr. p. 114
Step drills, Dec. p. 65
Stick-slip, Feb. p 197*; July p. 61
Stock guides*, Jan. p. 80
Stop, adjustable*, Mar. p. 79
Stop, punch and shear machine, June p. 81
Straight-line cams, Mar. p. 116
Strain gages, Apr. p. 97
Stress, alternating and static*, Mar. p. 204
Stress relief, steel, Dec. p. 50
Stress, residual, Dec. p. 75
Structural foil for hot parts*, Jan. p. 203
Stub drilling*, Apr. p. 104
Subzero machining*, Dec. p. 153
Super alloys, milling, Dec. p. 60
Supersonic sled, Apr. p. 97
Surface development, computers, Nov. p. 86
Surface finish, Jan. p. 109; Aug. p. 139*; Sept. p. 257*; Oct. p. 191*; Nov. p. 95 Dec. p. 61; Dec. p. 153*
bearingizing, Feb. p. 105
drilled holes, June p. 89; Dec. p. 65
gage blocks, Nov. p. 85
milling, Nov. p. 76
predicting, Nov. p. 81
reamed holes, July p. 48
Surgical tooling, June p. 72
Swaging
cold, Apr. p. 113
die design, Apr. p. 116
dissimilar materials, Apr. p. 116
high-strength alloys*, Jan. p. 107
machine, Apr. p. 114
Switches, limit*, Jan. p. 201
Switches, proximity*, Jan. p. 201
Surface
grinder attachment, Mar. p. 97
grinder, vertical, Sept. p. 105
preparation, June p. 85
preparation, bearingizing, Feb. p. 105
Synchrotron design, Dec. p. 37
Synchrotron, proton, Dec. p. 37
Synthetic diamonds*, Dec. p. 153

—T—

Tantalum welding, Jan. p. 116
Tap holder*, Jan. p. 83
Tap life, increasing, Aug. p. 76
Tape control, classes, Jan. p. 88
Tape controlled grinder, Mar. p. 100
Tape recorders*, Nov. p. 98
Tape template, Jan. p. 88
Taper machining, Dec. p. 44
Taper measurement, Jan. p. 85
micrometer, Jan. p. 85
Tapping*, May p. 103; Dec. p. 73*
fixture, shuttle*, Sept. p. 103
titanium, Aug. p. 83
tungsten, Oct. p. 80
Taps, old*, June p. 83
Taylor equation, July p. 81
Technology, functions of*, Sept. p. 260
Temperature
brazing, June 15 p. 88
grinding*, Sept. p. 252
measurement, Oct. p. 74
Template, grinding, Sept. p. 118
Testing
electrical control panels, Sept. p. 86
elevated temperature*, Apr. p. 333
grinding wheels, Oct. p. 84
magnetic-particle, Dec. p. 61
materials, Apr. p. 97
nondestructive, Dec. p. 61
spring materials*, Feb. p. 86
vibration and shock*, Apr. p. 338
Therapeutic tooling, June p. 72
Thermal distortions*, Oct. p. 191
Thermal instability, effect on measurement, Feb. p. 85
Thermatool welding, Jan. p. 122
Thermocouple materials, high-temperature*, Mar. p. 203
Thread
flattener*, June 15 p. 80
grinding, internal, Sept. p. 114
quality, July p. 66
Threading, automatic, Sept. p. 82
Threading, numerically controlled, June p. 98
Threads
angle deviation, July p. 69
deviation in lead, July p. 67
gaging, July p. 67

*Brief article less than 1 page.

Tie bar*, Oct. p. 78
Titanium, July p. 74
carbide, Nov. p. 99
grinding, Oct. p. 121
machining, Aug. p. 83
Tolerance charts, Aug. p. 68
Tolerances, Oct. p. 74
assembly, May p. 120
bearingizing, Feb. p. 105
positioning, July p. 65
Tonnage requirements, forging, Feb. p. 95
Tool and die
costs, Oct. p. 116; Nov. p. 110; Dec. p. 49
manufacture, Nov. p. 110
Tool
cost curve, June p. 108
engineering, Russia, Feb. p. 73
failure, Nov. p. 113
geometry, Apr. p. 97; Apr. p. 102; Apr. p. 305*; June 15 p. 83; Nov. p. 103
geometry, cutting, Oct. p. 79
geometry for drilling titanium, Aug. p. 83
geometry, reamers, July p. 48
life, June p. 84; June 15 p. 92; July p. 84; Nov. p. 76
life, ceramics and carbides, Aug. p. 55
life, cutting, Feb. p. 115
life, increasing, Nov. p. 110
life, milling cutters, July p. 85
life, single-point, June p. 117
life, taps, Aug. p. 76
life, turning, Nov. p. 94
joints, Mar. p. 89
lifting device*, June p. 82
materials, drilling titanium, Aug. p. 83
steels, characteristics of, Nov. p. 110
steels, weldable, July p. 77
wear, June p. 177*; Aug. p. 138*
wear, cutting, Apr. p. 100
Toolholder, boring tool*, Nov. p. 79
Toolholder, carbide, Jan. p. 98
Toolholders, mechanical, June p. 85
Tooling, June p. 101
ceramic and carbide, Aug. p. 55
costs, Oct. p. 102; Oct. p. 116
explosive forming, Apr. p. 112
fillet welding, June 15 p. 120
gun drilling, June p. 89
handicapped, for the, June p. 71
insert, June p. 85; June p. 114*; Sept. p. 97; Nov. p. 94
laminate, July p. 39
lathes, Sept. p. 93
low-cost, Oct. p. 102
low-production, May p. 99
missile, May p. 109
nuclear research, Dec. p. 37
optical, July p. 76
physical aid, June p. 72
prosthetic, June p. 72
spinning, Oct. p. 93
surgical, June p. 72
synchrotron, Dec. p. 40
therapeutic, June p. 72
Toolmaking, Dec. p. 49
Toolmaking, without machining, June p. 101
Tools
carbide*, Dec. p. 153
ceramic*, Oct. p. 192
drilling and tapping*, Apr. p. 90
heat-treatment, May p. 105
honing of, June p. 87
roller turner, June 15 p. 107
single-point, June p. 117
tungsten carbide, Oct. p. 79
Torch, vortex, Apr. p. 107
Torque converter design, Nov. p. 86
Torque fastener*, July p. 139
Tracer control, grinding, June 15 p. 89
Tracer machines, June 15 p. 111
hand-operated June 15 p. 111
Tracer milling, Apr. p. 120*; July p. 56
Transducer, displacement, Nov. p. 119
Transfer machine, Mar. p. 87; Apr. p. 78; Apr. p. 92; Apr. p. 93; July p. 50; July p. 56; Oct. p. 88; Oct. p. 90
Russian, Apr. p. 307
Transfer press*, Oct. p. 89
Treated wood, Jan. p. 113
Trends, metal removal*, Aug. p. 144
Trepan gage, combination*, Apr. p. 87
Trepanning, Sept. p. 86
Trichloroethylene, Mar. p. 84
Trolley brake*, Feb. p. 79
Tubing, punch*, May p. 85
Tungsten, Oct. p. 79
carbide tools, Oct. p. 79
coatings, June 15 p. 109
grinding, Oct. p. 121
Tunnel diodes*, June p. 95
Turning, see also Machining; Metalcutting
Turning, Sept. p. 91; Nov. p. 93
contour*, Oct. p. 106
ductile metals*, May p. 315
milling, and, Jan. p. 189
Turret lathe
automatic*, May p. 104
production, May p. 117
productivity, May p. 117
universal, Jan. p. 104
Turret loader, Dec. p. 57
Twin-fulcrum lever, Mar. p. 78

—U—

Ultrahigh-speed machining, Apr. p. 95
Ultrasonic
pickling*, June p. 87
soldering, Nov. p. 122
welding, Jan. p. 123
Unbalance
grinding wheel, Jan. p. 109; Oct. p. 95
sources, Oct. p. 96
Universal drill jig*, June p. 83
Uranium, swaging, Apr. p. 116

—V—

Valves, solenoid shut-off, Aug. p. 81
Vapor deposition, June 15 p. 110
Variable control, Dec. p. 61
Variable-speed slides, Sept. p. 121
Vibration
control*, June p. 211
dampening, Jan. p. 98
grinding*, Oct. p. 191
grinding wheels, Oct. p. 95
induced, Oct. p. 98
machine, Jan. p. 109
milling machine*, Sept. p. 251
shock, and*, Feb. p. 198
sound, and*, Aug. p. 144
Vise pads*, July p. 43
Vise parallels*, Oct. p. 76
Vortex torch, Apr. p. 107

—W—

Warpage, tool, Dec. p. 51
Weight calculation, bar stock, Mar. p. 95
Weld materials, austenitic, July p. 79
Weldable tool steels, July p. 77
Welding, June 15 p. 106; Oct. p. 104*; Dec. p. 58*
aluminum*, Oct. p. 105
aluminum alloy, May p. 116
automatic pipe*, Jan. p. 106
automotive assemblies*, Jan. p. 105
circumferential, May p. 116
crankshafts, Aug. p. 65
craters or holes, July p. 79
cycle, flash, Mar. p. 92
die sections, July p. 77
diffusion bond*, Oct. p. 197
electric beam, Jan. p. 115
electron beam*, Oct. p. 197
fillet, June 15 p. 120
fin stock*, Mar. p. 111
fixtures, Apr. p. 74
flash, Mar. p. 89
foil-seam, Jan. p. 123
hardened steel, July p. 78
high-frequency resistance*, Oct. p. 196
machine, Mar. p. 96
magnesium*, Feb. p. 197
magnetic-force, Jan. p. 123; Oct. p. 105*; Oct. p. 196*
percussion*, Oct. p. 196
preheating, July p. 79
pressure, Jan. p. 121
procedures, July p. 79
processes*, Oct. p. 196
progressive line, Aug. p. 48
resistance*, Dec. p. 71
rod manufacture, Mar. p. 110
rods, austenitic, July p. 80
skip, July p. 80
spiral, Jan. p. 123
stainless steel*, July p. 70
stress relief, July p. 80
ultrasonic, Jan. p. 123; Oct. p. 196*
Weldments*, Sept. p. 261
Wheel balancing methods, Jan. p. 110
Wheel dressing, automatic, Sept. p. 114
Wood, milling*, July p. 139
Wood, phenolic-treated, Jan. p. 113
Work driver*, June 15 p. 82
Work-energy method, Mar. p. 102
Work handling, May p. 82
Workhardening, hydrospark, Mar. p. 85
Workhardening prevention, June p. 96

—X-Y-Z—

X-ray diffraction, July p. 74
Young's modulus, Jan. p. 197*; June 15 p. 104
Yttrium*, Feb. p. 199
Zinc chromate, July p. 39
Zirconium
grinding, Oct. p. 121
welding, Jan. p. 116

Reference Sheet
May p. 123, Milling High-Strength Alloys
June p. 117, Tool Life of Single-Point Tools
July p. 85, Calculating Life of Milling Cutters
Aug. p. 83, Drilling, Reaming, Tapping Titanium
Oct. p. 121, Grinding Space-Age Materials
Nov. p. 121, Soldering Aluminum
Dec. p. 81, Designing Harmonic Cams

1960 ALPHABETICAL INDEX OF ADVERTISERS

This index of advertisers includes all advertisers who have appeared in THE TOOL ENGINEER 1960 and THE TOOL AND MANUFACTURING ENGINEER 1960, with the issues which carried their advertisements.

The index is published as a reader service. Although every precaution is taken to assure accuracy, no allowance will be made for error or omission.

***Exhibitor 1960 ASTME Engineering Conference and Expositions**

A

*AA Gage Co.—Nov.
A & C Engineering Co., Inc.—April
Accurate Bushing Co.—Jan., Apr., June, Directory, Sept., Oct., Nov.
*Ace Drill Bushing Co.—Jan., Feb., April, Directory
*Ace Drill Corp.—Feb., April, Directory, Sept., Oct., Dec.
Acme Industrial Co.—Jan., March, April, May, Sept., Nov.
*Adamas Carbide Corp.—Jan., March, April, June, Directory, Aug., Sept., Nov.
Addington—Aug.
*Adjustable Bushing Co.—Mar., May
*Advance Products Co.—July, Aug., Sept., Oct., Nov., Dec.
Airborne Accessories Corp.—Jan., Feb.
*Airborne Instruments Lab., Div. Cutler-Hammer —Feb., March, April, May, Directory, Aug., Oct.
*Airmatic Valve, Inc.—Directory
Air Valves Co.—April
*Alina Corp.—Jan., Feb., Mar., April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
Alkon Products Corp.—Feb., Sept., Oct., Nov., Dec.
*Allegheny Ludlum Steel Corp.—Jan., Feb., Mar., April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
Allen Mfg. Co.—Jan., Feb., Mar., April, May, June, July, Aug., Sept., Oct., Dec.
Allenair Corp.—Feb., May, July, Sept., Nov.
*Allied-Pacific Mfg. Co.—Nov.
*Allied Products Corp.—Richard Brothers Punch Div.—April, Directory, Aug., Oct., Dec.
Allied Tool Prods., Inc.—Jan.
*Almco Div., Queen Products, Div. King-Seeley Corp.—Feb., April, June, Directory, Aug., Nov., Dec.
Alpha Molykote Corp., The—Feb., April, June, Aug., Oct., Dec.
Amchem Products, Inc.—Directory, Sept.
*American Bechler Corp.—Feb., April
American Chain & Cable Co., Wilson Mechanical Instruments Div.—Feb., April, June, Aug., Sept., Dec.
*American Drill Bushing Co.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
*American Edelstall, Inc.—April
American Gage & Machine—April
American Machine & Foundry—Oct.
*American Pullmax Co., Inc.—Feb., April, Sept., Oct., Nov.
American Saw & Mfg. Co.—May, Sept.
*American SIP Corp.—Nov.
American Society for Metals—June
American Tool Works Co., The—Jan., Feb., March
*American Twist Drill Co., Subsidiary Cutting Tool Division Brown & Sharpe Mfg. Co.—Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Ames Co., B. C.—Jan., March, May, Directory, July, Oct., Dec.
Ames Precision Machine Works—April, Sept.
Anaconda American Brass Co.—Jan., Feb., Mar., April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Anchor Chemical Co.—Sept., Nov.
Anderson Corp.—Jan.
*Andrews Tool & Machine, Edward—Directory
Anton Machine Works—Oct., Nov., Dec.
Apex Broach Co., Inc.—April, June
Armstrong-Blum Mfg. Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Armstrong Bros. Tool Co.—Jan., Feb., March, April, May, June, Sept., Nov.
*Aro Equipment Corp.—April
*Arrowsmith Tool & Die Corp.—Directory, Nov.
Associated Winding Machine—May, Sept.
*Atlas Press Co., Clausing Division—Jan., Feb., March, April, May, June, Directory, Sept., Oct., Nov., Dec.
*Atrax Co.—Feb., May, July, Aug., Sept., Nov., Dec.
*Austin Industrial Corp.—Jan.
Automatic Mill, Inc.—Jan., Feb., March, April, May, June, Dec.
*Automation Devices, Inc., Perry Equipment & Eng. Div.—April, May, Directory, Aug., Sept.

B

*Baird Machine Co.—Feb., March, May, June, Directory, Aug., Sept.
Barber-Colman Co.—April, May, June, Directory, July, Aug., Sept., Nov., Dec.
Barnes Drill Co.—Jan., March, May, July, Aug.
*Barry Controls, Inc.—March, April
Bath & Co., John—Jan., Feb., March, April, May, June, July, Aug., Dec.
*Bausch & Lomb Optical Co.—Jan., March
Bausch Machine Tool Co.—Feb., Directory
Bay State Abrasive Products Co.—Feb., April, June, Dec.
Bay State Tap & Die Co.—Jan., April, May, Directory, Dec.
Beatty Machine & Mfg. Co., Beatty-Quickwork Division—Feb., April
*Beaver Pipe Tools, Inc.—Feb., April, May, July
Behr-Manning Co.—April, May, July, Dec.
*Bellows-Valvair—Jan., Feb., March, April, June, Aug., Oct., Nov.
*Bendix Corp., Industrial Controls Section—Nov., Dec.
*Bentley Industrial Corp.—April
*Besly-Welles Corp.—April, Directory
Bethlehem Steel Corp.—Feb., March, April, May, Directory, Sept., Oct., Nov., Dec.
Black & Decker Corp., Master Power Corp., Subsidiary—Jan., Feb., March, April, May, June, July, Aug., Sept., Dec.
*Blake Co., Edward—Feb., April, June
Blanchard Machine Co., The—Feb., April, May, July, Sept., Nov.
*Bliss Co., E. W., Die Supply Division—Sept., Dec.
Bloom Machinery, John I.—May, June, Sept.
Bodine Corp., The—Feb., Directory, Sept., Nov.
Boeing Airplane Co.—April
*Boggis Co., Henry P.—Oct., Nov., Dec.
*Boice-Crane Co., Inc.—March
Bokum Tool Co.—Dec.
Borg-Warner Corp., Rockford Clutch Division—Jan., Feb., Apr., March, May, June, July, Aug., Sept., Oct., Nov., Dec.
Boston Gear Works—March, April, May, Sept.
Boyar-Schultz Corp.—Feb., April, Dec.
*Branson Instruments, Inc.—Directory
Bremer Laboratories—Nov.
*Bridgeport Machines, Inc.—April, June, Directory, Aug., Oct., Dec.
*Brightboy Industrial Products Division, Weldon Roberts Rubber Co.—Jan., Feb., March, Sept., Oct., Nov.
*Briney Mfg. Co.—March, June
*Bristol Co., The—Jan., April, June, Sept., Nov., Dec.
*British Industries Corp., Shaw Process Division—Nov.
Brookfield, Inc.—March, April, May, July, Sept., Nov.
*Brown & Sharpe Mfg. Co.—Feb., April, May, June, July, Sept., Dec.
*Brown & Sharpe Mfg. Co., Cutting Tools Division—Jan., Feb., March, April, Directory, Sept., Oct., Nov., Dec.
*Brown & Sharpe Mfg. Co., Cutting Tools Division, American Twist Drill Co., Subsidiary—Feb., March, April, May, June, July, Sept., Oct., Nov., Dec.
Brown & Sharpe Mfg. Co., Nelco Cutting Tools Division—Jan., Feb., June, Dec.
Bruning Co., Charles—March, April, June, Aug., Oct., Dec.
Bryant Chucking Grinder Co.—March, May, July, Sept., Oct.
*Buck Tool Co.—Feb., March, Aug., Sept., Nov., Dec.
Bullard Co., The—Jan., Feb., March, April, May, June
*Burg Tool Mfg. Co.—April, Directory, Sept.
*Burgmaster Corp.—April, Directory, Sept.
Butterfield Division, Union Twist Drill Co.—Jan., Feb., March, May, June, Sept., Oct., Nov.

C

*Cadillac Gage Co.—March, April, June, Directory, Sept., Nov.
*Cadillac Stamp Co.—May, July, Sept., Nov.
*Campbell Machines Co.—April
Capewell Mfg. Co.—Jan., March, Sept., Oct., Nov.
Carborundum Co.—Sept., Oct., Nov., Dec.
Card Division, S. W., Union Twist Drill Co.—Jan., Feb., March, April, June, Directory, Sept., Oct., Nov.
Carney-Stansfield Co.—Directory
*Carr Lane Mfg. Co.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
*Cawi Machine Co., The—Sept., Oct., Nov., Dec.
*Cerro de Pasco Sales Corp.—Jan., March, May, Directory, July
*Challenge Machinery Co.—March, April
*Champion Pneumatic Machinery Co.—April
*Charmilles Engineering Works, Ltd.—Directory, Sept., Nov.
*Chaso Tool Co., Inc.—July, Sept., Nov.
Chicago Heights Steel Corp.—April, Sept.
Chicago Heights Steel Corp., Speedicut Division —Feb.
Chicago-Latrobe—Jan., April, May, Sept., Nov.
*Chicago Pneumatic Tool Co.—March, June, Sept., Nov.
*Chicago Rivet & Machine Co.—Feb., April, June, Aug., Nov., Dec.
Chicago Tool & Engineering Co.—July, Aug., Sept.
Chromalloy Corp.—Sintercast Division—March, April, May, Sept., Nov.
Cincinnati Milling Machine Co.—June, Dec.
Cincinnati Milling Machine Co., The, Grinding Machine Division—Feb., April
Cincinnati Milling Machine Co., Heald Machine Co., Subsidiary—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Cincinnati Milling Machine Co., Milling Machine Division—Aug., Sept.
*Cincinnati Sub-Zero Products—April
*Circular Tool Co.—Jan., Feb., April, Directory, Aug., Oct., Dec.
Clausing Division, Atlas Press Co.—Jan., Feb., March, April, May, June, Directory, Sept., Oct., Nov., Dec.
*Clearing Machine Corp., Division U. S. Industries, Inc.—Feb., April, June, Directory, Aug., Oct., Dec.
*Cleco Division, Reed Roller Bit Co.—Jan., Mar., April, Sept., Nov.
*Cleveland Instrument Co., Inc.—Jan., April, June, Directory, Sept., Nov.
Cleveland Twist Drill Co.—March, Directory, Dec.

Clipper Diamond Tool Co.—April
*Cogsdill Tool Products, Inc.—Feb., April, June, Directory, Oct., Nov., Dec.
Cogsdill Twist Drill Co., Inc.—Feb.
Columbia Tool Steel Co.—Jan., Feb., March, April, May, June, July, Aug., Nov.
Columbus Die-Tool & Mach. Co.—Oct., Dec.
*Commander Mfg. Co.—April
Comtor Co.—Jan., March, April
Continental Tool Works Division, Ex-Cell-O Corp.—Feb., April
Coolant Equipment Corp.—Nov., Dec.
Cooper Weymouth, Inc.—Feb., April, June, Aug., Nov., Dec.
*Coromant Division, Sandvik Steel, Inc.—Jan., March, April, June, Oct., Dec.
*Cosa Corp.—March, April, May, Directory, July, Sept., Oct., Nov.
*Crafts Co., Inc., Arthur A.—Jan., March, April, July, Aug., Sept., Nov.
*Crane Packing Co.—Feb., April, June, Sept., Oct., Nov.
Cratex Mfg. Co., Inc.—April, Directory
Crobalt Inc.—April, July, Sept., Oct., Nov.
*Crodian & Co.—April
Cross Co., The—March, April, June, Aug., Oct., Dec.
*Crucible Steel—June, July, Aug., Sept., Oct., Nov.
*Crystal Lake Grinders—April
*Cushman Chuck Co.—Feb., April, June, Directory, Sept., Oct., Dec.
Cutler-Hammer Co., Airborne Instruments Laboratory, Division—Feb., March, April, May, Directory, Aug., Oct.
Cutter Division, The Ingersoll Milling Machine Co.—Feb., April, May, July, Sept., Nov.

D

Dahlstrom Machine Works, Inc.—Feb.
*Danly Machine Specialties, Inc.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Dec.
Davis Division, Giddings & Lewis Machine Tool Co.—April, Directory
*Davis Gage & Engineering Co., A. G.—June, July, Sept., Oct., Nov.
Dawson Carbide Industries, Inc.—Directory
Dayton Rogers Mfg. Co.—Jan., March, May, July, Sept., Nov.
Dearborn Gage Co., Ellstrom Standards Division—Feb., March, April, Directory, Aug., Sept., Oct., Nov.
Dearborn Machinery Movers, Co., Inc.—April, Directory
Delta Power Tool Division, Rockwell Mfg. Co.—Feb., April, May, June, Aug., Oct., Nov.
Derbyshire Inc., F. W.—April
Detroit Mold Engineering Co.—April, Directory
*Detroit Stamping Co.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
*Devcon Corp.—April, May, June, Directory, Aug., Sept., Nov.
*DeVlieg Machine Co., Jigmill Division—Feb., Directory
*DeVlieg Machine Co., Microbore Division—Jan., March, April, July, Sept., Nov.
Dexco Corp., Raymac Division—Directory, Oct., Nov., Dec.
Dickerman Mfg. Co., H. E.—Jan., Feb., April, June, Sept., Nov.
*Di-Dro Engineering Co.—April
*Dixie Tool Industries—Feb., April, May, July, Aug.
*DoALL Co.—Jan., Feb., March, April, May, Directory, July, Oct., Nov.
*Doerr Electric Corp.—April
*Dow Chemical Co., The—Dow Metal Prods. Co., Div., The—Feb., March., April, May, June, July, Aug., Sept., Nov., Dec.
Dow Mech. Co.—Dec.
*Drillmation Co., Inc.—Directory
*duMont Corp., The—April, Directory
*Dumore Co., The—Jan., Feb., April, May, Directory, Sept., Nov.
*Dundick Tool Works, Inc.—April
*Dunham Tool Co.—Sept., Oct., Nov.
*Durant Tool Co.—Oct., Nov., Dec.
Dwight Instrument Co.—Sept., Oct., Nov., Dec.
Dykem Co., The—Jan., Feb., April, May, June, July, Aug. Sept., Oct., Nov., Dec.
Dynapak, Convair, A Division of General Dynamics Corp.—Feb., April, June, Aug., Sept., Oct., Dec.

E

Eastern Machine Screw Corp., The—Jan., May, Aug., Oct., Nov.
Eastman Kodak Co.—Jan., Feb.
*Eclipse Counterbore Co.—April, May, Directory, July, Sept., Nov.
*Edgcomb Engineering & Engraving Co.—Directory, Nov.
Edlund Machinery Co.—Feb., April, Sept., Oct., Dec.
Ehrhardt Tool & Machine Co.—April, Directory
Eldorado Tool & Mfg. Co.—April, Directory, July, Sept., Nov.
Electrons, Inc.—Feb., May, Aug., Nov.
Elliott Mfg. Co.—Feb., April, Aug., Oct., Dec.
Elliott Vibrator Div., M-F Equipment Co.—Feb., April, June, Aug., Oct., Dec.
Ellstrom Standards Division, Dearborn Gage Co.—Feb., March, April, Directory, Aug., Sept., Oct., Nov.
*Emhart Mfg. Co.—Feb., April, July, Sept., Nov.
Empire Magnetics, Inc.—Feb.
*Engelhard Hanovia, Inc., Industrial Diamond Division—Jan., May, July, Dec.
Engelhard Hanovia, Inc., National Electric Instrument Division—Feb., March, June, Sept., Nov.
*Engis Equipment Co., Hyprez Division—April, July, Sept., Nov.
*Eonic Inc.—Aug., Nov.
*Erickson Tool Co.—April, July, Sept., Oct.
*Erico Products Inc.—Directory, Nov.
Ernest, Holdeman & Collett, Inc., Speedgrip Chuck Division—Jan., March, May, July, Sept., Nov.
Errington Mechanical Laboratory—April
*Ettco Tool & Machine Co., Inc.—Jan., April
*Ex-Cell-O Corp.—Jan., Feb., April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
Ex-Cell-O Corp., Continental Tool Works Division—Feb., April
Ex-Cell-O Corp., Robbins Sine Plates, Greenville, Ohio Plant—Feb., April, June, Directory, Aug., Oct., Dec.
*Ex-Cell-O Corp., Optical Gaging Products Subsidiary—July, Sept., Oct., Nov., Dec.

F

F & D Tool Co.—Sept., Oct., Nov.
*Falcon Tool Co.—Directory
*Famco Machine Co.—Feb.
Federal-Bryant Machinery Co.—Feb., Aug.
*Federal Products Corp.—Jan., March, April, Directory, July, Sept., Oct., Nov., Dec.
*Fellows Gear Shaper Co.—Feb., April, May, Directory, July, Sept.
*Fenway Machine Co.—April, Directory, Nov.
Flick-Reedy Corp., Miller Fluid Power Division—Feb., April, Directory
*Flodar Corp.—Directory
Ford Mfg. Co., M. A.—Directory
Fulton Iron Works Co., Lehmann Boring Tool Division—April, Sept., Nov.
*Futurmill, Inc.—April, Directory, Aug., Oct.

G

*Gaertner Scientific Corp.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Gairing Tool Co.—Directory
*Galland-Henning Mfg. Co.—Directory
*Gammons-Hoaglund Co., The—April
*Gardner-Denver Co.—Jan., Feb., April, May, Directory, Aug., Oct., Dec.
Gatco Rotary Bushing Co.—Feb., April, June, Aug., Oct., Dec.
*General American Transportation Corp., Parker-Kalon Division—Jan., April, Directory, Aug., Sept., Nov.
General Dynamics Corp., Dynapak Convair, A Division—Feb., April, June, Aug., Sept., Oct., Dec.
*General Electric Co., Metallurgical Products Dept.—Jan., April, June, July, Aug., Nov., Dec.
*General Electric Co., Silicone Products Dept.—April, Directory
General Motors Corp., Oldsmobile Division—Feb., April
General Motors Research Laboratories—Jan., Feb., March, April, May, June, Sept., Oct., Nov.
*George Machinery Co., James W.—April, Sept.
Giddings & Lewis Machine Tool Co., Davis Division—April, Directory
*Gilman Co., Russell T.—April, Directory
*Gisholt Machine Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Gorton Machine Co., George—Jan., March, June
Goss & DeLeeuw Machine Co.—Sept.
*Grant Mfg. & Machine—July, Aug., Sept.
*Graymills, Inc.—April, June, Sept., Oct., Nov., Dec.
Greaves Machine Tool Co.—Jan., March, Aug., Sept.
*Green Instruments Co.—Feb., April
Greenfield Tap & Die Co.—Feb., April, May, June, Directory, Nov.
Greenlee Bros. & Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Greensboro Industrial Platers, Inc.—July, Aug., Sept.
*Grob, Inc.—April, June, Aug., Oct., Dec.
*Grobet File Co. of America—April, June, Directory, Nov.
*Grotnes Machine Works—Jan., Feb., April
*Gulf Oil Corp.—Feb., March, April, May, Sept., Oct.
Gulton Industries, Inc.—Jan., Feb., March, April
*Guthrey Machine Tool Corp.—March

H

*Hammond Machinery Builders, Inc.—Jan., April, Oct.
*Hanchett-Magna-Lock Corp.—Directory
Hanna Engineering Works—April
*Hannifin Co., Division Parker-Hannifin Corp.—Jan., Feb., March, April, May, June, Sept.
Hanson-Whitney Co.—March, April, June, Sept.
Hardinge Brothers, Inc.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Harig Mfg. Corp—March, May, Oct.
*Harnischfeger Corp.—April
Hartex Division (West Germany) Union Twist Drill Co.—April
*Hartford Special Machinery Co.—Feb., March, April, May, June, Sept., Oct., Nov., Dec.
Hayes, Inc., C. I.—April
Heald Machine Co., Subsidiary Cincinnati Milling Machine Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Heinrich Tools, Inc.—April
Heller Roberts Mfg. Corp.—Nov.
*Hermes Machine Tool Co.—April
High Precision Products—April, Sept.
High Standard Mfg. Corp., The—April, Oct.
Hirschmann, Inc., Carl—Jan., Feb., March, April
Hoggson & Pettis Mfg. Co.—Jan., March, May, July, Sept., Nov.
Hoglund Engineering Co.—April
Holcroft & Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Homestrand Machine Tool Corp.—Directory
Houdaille Industries, Inc.—Oct.
*Hudson Division, Emhart Mfg. Co.—Feb., April, July, Sept., Nov.
*Hughes Industrial Systems, Hughes Aircraft Co.—March, April, Nov., Dec.
*Hunt Valve Co.—Directory, Oct., Dec.
*Huron Machine Products—Jan., April, Oct.
Hutchinson Co., Wm. T.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Hyprez Division, Engis Equipment Co.—April, July, Sept. Nov.
Hy-Pro Tool Co.—April, Directory, Nov.
Hysol Corp.—Feb., April, June, Oct.

I

*Ideal Industries, Inc.—Feb., April, June, Directory, Aug., Sept., Oct.
Illinois Tool Works, Tool & Instrument Division—April, June, Aug., Sept., Oct., Nov.
*Index Machine Co.—Directory, Nov.
Induction Heating Corp.—Feb., April, June, Aug., Oct., Dec.
*Industrial Controls Section, Bendix Corp.—Nov., Dec.
*Industrial Diamond Division, Engelhard Hanovia, Inc.—Jan., May, July, Dec.
*Ingersoll Milling Machine Co., The, Cutter Division—Feb., April, May, July, Sept., Nov.
*Ingersoll-Rand Co.—May, Directory
International Basic Economy Corp., Bellows-Valvair—Jan., Feb., March, April, June, Aug., Oct., Nov.
Investment Casting Co.—June

J

Jacobs Mfg. Co.—March, April, May, June, Sept., Nov.
Jahn Mfg. Co., The B.—Jan., March, May, July, Sept., Nov.
Japan Die & Tool Exporters Co., Ltd.—April
*Jarvis Corp.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Jergens Tool Specialty Co.—May, Nov.

Jersey Mfg. Co.—Jan., Feb., April, June, Sept., Nov.
*Jigmill Division, DeVlieg Machine Co.—Feb., Directory
Johnson Machine & Press Corp.—April, Aug.
*Jones & Lamson Machine Co.—April, May, Aug., Oct., Nov., Dec.

K

*Kalamazoo Tank & Silo Co., Machine Tool Division—Feb., April, Directory, Oct.
Kaufman Mfg. Co.—March, July, Nov.
Kearney & Trecker Corp.—Jan., Feb., March, April, Aug.
*Kennametal, Inc.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
Kenville Tool & Engineering—Sept., Oct., Nov.
Keuffel & Esser Co.—Sept.
*King-Seeley Corp., Almco Queen Products Division—Feb., April, June, Directory, Aug., Nov., Dec.
King Tester Corp.—Jan., March, May, Sept., Nov., Dec.
Kingsbury Machine Tool Corp.—Feb., May, July, Sept., Nov., Dec.
*Kuzmick Co., The Paul L.—Jan., Feb., March, April, May

L

*Lake Erie Machinery Corp.—April
*Lapeer Mfg. Co.—Jan., March, April, May, Directory, July, Sept., Nov.
Lapointe Machine Co.—Jan., May, Directory! Sept., Oct., Nov., Dec.
Lapointe Machine Tool Co.—Feb., April, June, Directory, Sept., Oct., Dec.
Lassy Tool Co.—Nov., Dec.
*Latrobe Steel Co.—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
*Lee Co., K. O.—Jan., Feb., March, April, June, Aug., Oct., Nov.
Lees-Bradner Co.—Directory
Lehman Boring Tool Division, Fulton Iron Works—April, Sept., Nov.
Lehman-Fulton Boring Tool Co.—April, Sept., Nov.
*Leland-Gifford Co.—Jan., March, May, June, Directory, Sept., Nov.
Lempco Industrial, Inc.—Jan., April, Nov., Dec.
Lepel High Frequency Labs—Feb., April, June, Sept., Oct., Dec.
Lincoln Electric Co.—June, Sept., Nov.
*Lincoln Industries Co.—April
Lindberg Engineering Co.—Jan., March, April, May, June, Sept., Oct., Nov., Dec.
Linde Co., Division Union Carbide Corp.—Oct., Nov., Dec.
Linderme Engineering & Sales—Sept., Oct., Dec.
Link Aviation, Inc.—March, April, Oct.
Lipe Rollaway Corp.—Oct., Nov.
*Littell Machine Co., F. J.—Feb., April, May
*Livernois Engineering Co.—Feb., May, Directory, July, Sept.
Loeffel Co., The Arthur—April
*Logan Engineering Co.—Feb., March, April, Directory, Aug., Sept.
*Logansport Machine Co.—Jan., April, May, July, Sept., Nov.
*Lovejoy Tool Co.—Feb., April, June, Aug., Oct., Dec.
*Lufkin Rule Co.—Jan., March, May, Directory, July, Sept., Nov.

M

*M-B Products Corp.—March, April, June, Aug., Oct., Nov.
*MBI Export & Import, Ltd., Division of Machinery Builder, Inc.—April
M-F Equipment Co., Elliott Vibrator Division—Feb., April, June, Aug., Oct., Dec.
*Madison Industries, Inc.—Sept., Oct., Nov.
*Mahr Gage Co.—Jan., Feb., March, June, Oct.
Manex Machinery Corp.—April
Manhattan Rubber Division, Raybestos-Manhattan, Inc.—Jan., April, May, Sept., Oct., Nov., Dec.
*Marac Machine Co.—March, May, June, Sept.
Marshall Steel Co.—May
Marvel Tool & Machine Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Master Power Corp., Subsidiary Black & Decker Corp.—Jan., Feb., March, April, May, June, July, Aug., Sept., Dec.
*Mayline Co., Inc.—Feb., April, May, Aug., Oct., Dec.
*McCrosky Tool Corp.—March, April, May, June, Sept., Oct.
McGraw-Hill Publishing Co.—Sept.
*Merit Products—Jan., Feb., March, April, May, June.
*Metal Carbides Corp.—April, June, July, Sept., Nov.
*Metal Cutting Tools, Inc.—July, Aug., Sept.
*Metallurgical Products Dept., General Electric Co.—Jan., April, June, July, Aug., Nov., Dec.
Meyers Co., W. F.—Jan., Feb., March, April, June, July, Aug., Sept., Oct., Nov., Dec.
Michigan Oven Co.—Oct., Nov., Dec.
Michigan Special Machine Co.—April
Michigan Tool Company—June, Sept., Dec.
*Microbore Div.—DeVlieg Mach. Co.—Jan., March, April, July, Sept., Nov.
*Micrometrical Mfg. Co.—Jan., Feb., April, July, Sept., Nov.
Milford Rivet & Machine Co.—Feb., March, Sept., Oct., Nov.
Miller Fluid Power Division, Flick-Reedy Corp.—Feb., April, Directory
Millers Falls Co.—Sept.
*Modern Industrial Engineering Co.—April
*Mohawk Tools, Inc.—Jan., April, June, Aug., Sept., Nov.
*Monroe Engineering Products, Inc.—Directory
Montgomery & Co., Inc.—April, Sept.
*Moore Special Tool Co.—Feb., April, May, Directory, Sept., Nov., Dec.
Morris Co., Robert E.—Jan., March, May, July, Sept., Nov.
*Morse Co., H. E.—Directory
Morse Twist Drill & Machine Co., Subsidiary Van Norman Industries, Inc.—Feb., April, May, June, July, Aug., Sept. Nov., Dec.
Mueller Brass Co.—Directory
*Muskegon Tool Industries, Inc.—Directory

N

Nakashima International Corp., S.—Nov.
*National Acme Co., The—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*National Broach & Machine Co.—Jan., March, April, July, Sept., Nov.
National Electric Instrument Div., Engelhard Hanovia, Inc.—Feb., March, June, Sept., Nov.
National Institute of Jig & Fixtures Component Manufacturers—Directory
National Machine Tool Builders Association—April, May, July, Aug.
National Machinery Co.—Feb., April, May, June, July, Aug., Sept., Oct., Dec.
National Tool Co.—Jan., March, May, July Sept.
National Twist Drill & Tool Co.—Jan., March, April, Directory, Sept., Nov.
*Nelco Cutting Tool Div., Brown & Sharpe Mfg. Co.—Jan., Feb., April, Directory, Sept., Oct., Nov., Dec.
New Bedford Industrial Development Commission—April
New England Tap Co., Inc.—April
New York Twist Drill Co., Inc.—Feb., April, June, Aug., Oct., Dec.
*Newage Industries, Inc.—July, Aug., Sept., Oct., Nov., Dec.
Newcomer Products—April, Nov.
*Newton Hydraulic Tooling Co.—March, April, June, July, Sept., Dec.
Nice Ball Bearing Co.—April, Aug., Nov.
*Nikon, Inc.—Jan., March, April, June, Sept., Nov.
Nilson Machine Co., The A. H.—Jan., March, May, July, Sept., Nov.
Norden Division, United Aircraft Corp.—July, Sept., Nov.
*Norgren Co., C. A.—Feb., April, May, June July, Aug., Sept., Oct., Nov., Dec.
North Electric Co.—March, April, May, July
*Northwestern Tools, Inc.—Jan., April, June, Directory, July, Sept., Nov.
Norton Co., Abrasive Grinding Wheel Division—March, April, June, Directory, Sept., Dec.
Norton Co., Behr-Manning Co., Div.—March, April, May, Sept., Dec.
Norton Co., Machine Division—Feb., March, May, Aug., Sept.

O

*O. K. Tool Co., Inc.—Jan., Feb., March, April, May, June, Directory, Dec.
*Oakite Products, Inc.—Jan., March, April, May, July, Sept., Oct., Nov.
*Ohio Crankshaft Co., Inc.—Feb., April, June, Aug., Sept., Nov.
Oldsmobile Division, General Motors Corp.—Feb., April
*Olivetti Corporation of America—April, Directory, Nov.
*Olsen Testing Machine Co., Tinius—Feb., April, June, Aug., Oct., Dec.
Onstud Machine Works, Inc.—Jan., Feb.
*Optical Gaging Products, Subsidiary Ex-Cell-O Corp.—July, Sept., Oct., Nov., Dec.
Opto-Metric Tools, Inc.—Feb., April, Sept., Nov.
*Ortman-Miller Machine Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Osborn Mfg. Co.—Jan., Feb., April, June, Aug., Nov., Dec.

P

*P.I.C. Design Corp.—June
Paddock Tool Co.—Directory
*Pangborn Corp., Vibratory Finishing Division—March, May, July, Oct.
*Parker-Fittings & Hose Div., Parker-Hannifin Corp.—Jan., Feb., March, April, May, Directory, Oct., Dec.
*Parker-Hannifin Corp., Hannifin Co., Division—Jan., Feb., March, April, May, June, Sept.
*Parker Hydraulics Division, Parker-Hannifin Corp.—April
*Parker-Kalon Corp., Division General American Transportation Corp.—Jan., April, Directory, Aug., Sept., Nov.
Parker-Majestic, Inc.—Jan.
*Payne Tool & Engineering Co.—Feb., July, Aug., Sept., Oct.
Pekay Abrasives, Inc.—Jan., Feb., March, April, May
Penn Scientific Products—April
Penninsular Grinding Wheel Corp.—May, Oct., Dec.
*Perry Equipment & Engineering Co., Division Automation Devices, Inc.—April, May, Directory, Aug., Sept.
Petz-Emery, Inc.—Feb.
*Pines Engineering Co., Inc.—Jan., March, April, Aug., Nov.
Pipe Machinery Co.—Jan., March, May, Directory, July, Aug., Oct., Dec.
Pope Machinery Corp.—Jan., Feb., March, April, May, June, Aug., Sept., Oct., Dec.
*Porter Co., Inc., H. K.—Directory
Power Grip, Inc.—April, Aug., Sept., Oct.
Pratt & Whitney Co., Inc.—Jan., Feb., March, April, May, June
*Precise Products Corp.—June, Aug.
*Precision Tool & Mfg. Co.—March, April, Sept., Dec.
Preis Engraving Machine Co.—Oct.
*Producto Machine Co., The—Jan., March, April, May, Directory, Sept., Oct., Dec.
*Punch Products Corp.—Jan., April, Directory, Aug.

Q

Quartz Radiation Corp.—Sept., Oct., Dec.
*Queen Products Division, Almco, King-Seeley Corp.—Feb., April, June, Directory, Aug., Nov., Dec.

R

*R-O Mfg. Co.—April
*Radio Corp. of America—Directory
Raybestos-Manhattan, Inc., Manhattan Rubber Division—Jan., April, May, Directory, Sept., Oct., Nov., Dec.
Raymac Division, Dexco Corp.—Directory, Oct., Nov., Dec.
Ready Tool Co.—Directory, Sept., Oct., Nov., Dec.
Reed Rolled Thread Die Co.—Feb., April, June, Sept., Oct., Nov.
*Reed Roller Bit Co., Cleco Division—Jan., March, April, Sept., Nov.
Reid Brothers Co.—Directory
*Rem Sales Inc., Subsidiary Robert E. Morris Co., The—March
*Ren Plastics, Inc.—April, Oct.
*Richard Brothers Punch Division, Allied Products Corp.—April, Directory, Aug., Oct., Dec.
*Richards Co., J. A.—April, Directory

Rider Publisher, Inc., John F.—June, Aug.
Ring Punch & Die, Inc.—Jan., Feb., March, May, Sept., Oct., Nov.
Rivett Lathe & Grinder, Inc.—Feb., March, May, June, Sept., Oct.
Robbins Sine Plates, Greenville, Ohio Plant, Ex-Cell-O Corp.—Feb., April, June, Directory, Aug., Oct., Dec.
Rockford Clutch Division, Borg-Warner Corp.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Rockford Engineered Products Co.—Oct., Nov.
*Rockwell Mfg. Co., Delta Power Tool Division—April, May, June, Aug.
*Rockwell Mfg. Co., Walker-Turner Division—Jan., March, May, Directory, Nov.
*Ross Operating Valve Co., Inc.—April, Directory
*Rotor Tool Co.—Feb., March, April, June, Sept., Nov.
Royco Tap & Tool Co.—Aug., Oct., Dec.
Russell, Holbrook & Henderson, Inc.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Dec.
Ryerson & Son, Inc., Jos. T.—Feb., April, June, Aug., Oct., Dec.

S

S-P Manufacturing Co.—Directory
*S & E Machine Products, Inc.—April, June, Sept.
*Sandvik Steel, Inc., Coromant Division—Jan., March, April, June, Oct., Dec.
*Scharmann Machine Corp.—Directory
*Scherr-Tumico, Inc.—Jan., March, April, May, Directory, Sept., Oct., Dec.
*Schmidt, Inc., George T.—April, June, Sept., Nov.
*Schrader's Son, A.—Jan., March, May, July, Sept., Nov.
*Schramm Inc.— March
*Scully-Jones & Co.—April, May, Directory, July, Sept., Oct., Nov.
*Seibert & Sons, Inc.—Feb., April, Directory, Aug., Oct., Dec.
*Sentry Co., The—Feb., April, June, Aug., Oct., Dec.
*Service Machine Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Service Research & Development Co., Inc.—May, June, July
Sesco, Inc.—April
*Severance Tool Industries, Inc.—Jan., March, May, July, Sept., Nov.
*Shaw Process Div., British Industries Corp.—Nov.
*Sheffield Corp., The—April, Sept.
*Sheldon Machine Co.—Jan., Feb., March, April, Sept., Oct., Nov., Dec.
Shell Chemical Corp.—April, June, Aug., Oct.
Sier-Bath Gear & Pump Co.—Sept.
*Siewek Tool Co.—Directory
*Sigma Machinery Inc.—April
*Silicone Prods. Dept., General Electric Co.—April, Directory
*Simonds Abrasive Co.—Jan., March, April, June, Sept., Nov.
*Simonds Saw & Steel Co.—Jan., Feb., March, April, May, June, Sept., Oct., Nov.
*Simpson Optical Mfg. Co.—Feb., April, May, Sept., Nov., Dec.
Sinclair Refining Co.—March, May, Sept., Oct., Nov., Dec.
*Sintercast Division Chromalloy Corp.—April, March, May, Sept., Nov.
*Size Control Co.—April
*Skinner Chuck Co., The—March, April, Directory, Aug., Sept.
*Skinner Electric Valve Div., Skinner Chuck Co.—Directory
Slocomb Co., J. T.—Feb., April, Oct., Dec.
Smith & Son, Inc., James—Dec.
Snow Mfg. Co.—Jan., Directory, Sept.
Snyder Corp.—April, Directory
Somma Tool Co., Inc.—April
Sonnet Tool & Mfg. Co.—Jan., June
Sossner Tap & Tool Corp.—Jan., March, May
Southwest Products Co.—Feb., April, June, Aug., Dec.
Special Drill & Reamer Corp.—April
*Special Engineering Services—April
Speedgrip Chuck Div., Ernest, Holdeman & Collett, Inc.—Jan., March, May, July, Sept., Nov.
Speedicut Division, Chicago Heights Steel Co.—Feb.
*Spiral Carbide Tool Co.—Feb., April
*Spiral Step Tool Co.—May, June, Sept., Oct., Nov.
Standard Die Set Co.—April, Directory
*Standard Electrical Tool Co.—Jan., March, April, June, Aug., Sept., Oct., Nov., Dec.
*Standard Pressed Steel Co.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Standard Tool Co.—Jan., April, May, July, Sept., Nov.
*Standard Tool & Mfg. Co.—April, July, Sept., Oct., Dec.
*Starlite Industries, Inc.—July, Aug., Sept.
*Starrett Co., The L. S.—Jan., April, May, Oct., Nov.
Staset Co., Inc.—May, June
Stein Co., Inc., Wm. P.—April
Stilson Tool Co.—April, July, Sept., Oct., Nov.
Stocker & Yale, Inc.—March, April, May, Sept., Oct., Nov.
Stone Machinery Co., March, Nov.
Stuart Oil Co., Ltd., D. A.—Feb., March, April, Directory, June, Sept.
Sturtevant Co., P. A.—Jan., March, May, July, Sept., Nov.
Sun Oil Co.—March, April, May, July, Sept.
Sundstrand Machine Tool Div., Sundstrand Corp.—Feb., April, May, July, Sept., Nov.
*Sunnen Products Co.—April, Directory, Aug., Oct., Nov.
Super Tool Co., Division Van Norman Industries—April, Directory, Sept.
*Superior Hone Corp.—Sept.
*Superior Steel Products Corp.—Feb., March, April, May, Directory, June, July, Aug., Sept., Oct., Nov.
*Supreme Products Corp.—Nov.
*Sykes Machine & Gear Corp.—April, Directory
*Sylvania Lighting Products—June, July, Aug., Sept., Oct., Nov.

T

Taper Micrometer Corp.—Feb.
Techno-Products Corp.—July, Aug., Sept.
Textron, Inc., Waterbury Farrel Foundry & Machine Co., Div.—Feb., April, Sept.
Thompson Grinder Co.—Jan., March, May, July, Aug., Sept., Dec.
*Thompson Industries, Inc.—Oct., Dec.
Thompson & Son, Henry G.—Jan., March, April, May, Directory, Oct.
*Thor Power Tool Co.—April, May, June, July, Aug., Sept., Oct., Nov., Dec.
*Threadwell Tap & Die Co.—Jan., Feb., March, April, May, June, Aug., Sept., Oct., Nov., Dec.
*Thriftmaster Products Corp.—Feb., March, May, July, Sept., Nov.
Tietzman Tool Corp.—Directory, Aug., Oct., Nov., Dec.
Timken Roller Bearing Co.—Feb., April, June, Aug., Oct., Dec.
*Tinius Olsen Testing Machine Co.—Feb., April, June, Aug., Oct., Dec.
Titan Tool Co.—Jan., March, May, June, Sept., Oct., Nov.
*Tocco Div., Ohio Crankshaft Co., Inc.—Feb., April, June, Aug., Sept., Nov.
*Tomkins-Johnson Co.—Feb., April, Directory, June, Aug., Sept., Dec.
Torrington Co., The—Feb., May, Oct.
Torrington Mfg. Co.—Feb., April, July, Sept., Oct., Dec.
*Tracer Control Co.—Directory
Transmares Corp.—Jan., March, May, Directory, Nov.
Triax Co., The—Sept., Dec.
Twentieth Century Mfg. Co.—Feb., April, June, Sept., Oct., Nov.

U

*Uddeholm Co. of America, Inc.—Jan., March, April, July, Sept., Nov.
Unimet Carbides Corp.—Feb. April, May, Sept., Oct., Nov., Dec.
Union Carbide Corp., Linde Co., Division—Oct., Nov., Dec.
Union Carbide Plastics Co.—April, Directory, Sept., Nov.
*Union Mfg. Co.—March, April, May, June, Sept., Oct.
Union Twist Drill, Hartex Division—April
*Union Twist Drill Co., S. W. Card Division—Jan., Feb., March, April, June, Directory, Sept., Oct., Nov.
*Union Twist Drill Co., Union Division—Jan., Feb., April, June, Sept., Oct., Nov.
United Aircraft Corp., Norden Division—July, Sept., Nov.
United Greenfield Corp., Geometric-Horton Division—Feb., April, Sept., Nov.
United Greenfield Corp., Greenfield Division—Feb., April, May, June, Directory, Nov.
U. S. Diamond Wheel Co.—Oct.
U. S. Drill Head Co.—April, Directory, Sept.
*U. S. Industries, Inc., Clearing Machine Corp.—Feb., April, June, Directory, Aug., Oct., Dec.
*U. S. Tool Co., Inc.—Jan., April, June, Directory, Aug., Sept.
Unitron Instrument Div., United Scientific Co.—Feb., Sept., Nov.
*Universal Automatic Corp.—April
Universal-Cyclops Steel Corp.—Jan., March, April June, Dec.

V

*Valenite Metals—Sept., Oct., Nov.
Valvair Corp.—March, May
*Vanadium-Alloys Steel Corp.—Feb., March, Directory, Aug., Oct., Nov.
*Van Keuren Co., The—April, Directory, Sept.
Van Norman Industries, Inc., Morse Twist Drill & Machine Co.—Feb., April, May, June, July, Aug., Sept., Nov., Dec.
Van Norman Industries, Inc., Super Tool Co. Division—April, Directory, Sept.
*Vascoloy-Ramet Mfg. Corp.—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.
Vee-Arc Corp.—Jan., Feb., March, April, May, June
Verbiest Associates, Inc., C. M.—Oct.
Verson AllSteel Press Co.—Jan., March, May, July, Sept., Nov., Dec.
Vibratory Finishing Division, Pangborn Corp.—May
*Vidmar, Inc.—April
*Vlier Engineering, Inc.—Jan., March, May, June, July, Aug., Sept., Nov.
*Vlier Engineering, Inc., Wespo Division—Feb., April, June, Aug., Oct., Dec.

W

Waldes Kohinoor, Inc.—Jan., Feb., April
*Wales-Strippit, Inc.—Feb., April, June, Directory, Aug., Sept.
*Walker, O. S., Co.—April
*Walker-Turner Division, Rockwell Mfg. Co.—Jan., March, May, Directory, Nov.
Wallace Supplies Mfg. Co.—May
Walsh Press & Die Co.—April
Waterbury Farrel Foundry & Machine Co., Division of Textron, Inc.—Feb., April, Sept.
Warren Electr-O-Line Corp.—Nov., Dec.
*Watts Regulator Co.—April, Sept.
*Webber Gage Co.—April, July, Dec.
*Weldon Roberts Rubber Co., Brightboy Industrial Products Division—Jan., Feb., March, Sept., Oct., Nov.
*Weldon Tool Co., Inc.—Feb., April, May, Sept., Nov.
*Wender Presses Inc.—April
*Wespo Division, Vlier Engineering, Inc.—Feb., April, June, Aug., Oct., Nov., Dec.
Wesson Co.—Feb., March, May, Directory, July, Sept., Nov.
Wheatley Economy Die Sets, Inc.—Nov., Dec.
*Wheel Trueing Tool Co.—April, May, Directory, Sept., Nov.
*Whistler & Sons, Inc., S. B.—Feb., April, June, Directory, Aug., Oct., Dec.
Whitman & Barnes, Inc.—Jan., March, May, Directory, Sept., Nov.
*Whitnon Mfg. Co., The—Jan., April
Wiedemann Machine Co.—March, May, Aug.
Wilkerson Corp.—April
Willey's Carbide Tool Co.—Directory
Wilson Mechanical Instrument Division, American Chain & Cable Co.—Feb., April, June, Aug., Sept., Dec.
*Wilton Tool Mfg. Co., Inc.—Feb., April, June, Aug.
Winter Brothers Division, National Twist Drill & Tool Co.—Jan., March, April, Directory, Sept.
*Wintress, Inc.—April
*Wisconsin Drill Head Co.—April, Sept.
Woodruff & Stokes, Inc.—Feb., March, April, May, June, Sept., Nov.
Woodson Tool Co.—Feb., May, Aug., Nov.
*Woodworth Co., N. A.—Feb., April, June, Nov.

Y

Yoder Co., The—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec.

Z

*Zagar, Inc.—March, April, Aug., Sept., Nov.
*Zeiss, Inc., Carl—Jan., Feb., March, April, May, June, Directory, July, Aug., Sept., Oct., Nov., Dec.
*Ziegler Tool Co., W. M.—Jan., March, May, July, Sept., Nov.

The 1961
ASTME
ENGINEERING
CONFERENCE
AND
EXPOSITION
May 22-26
at
NEW YORK COLISEUM
THE AMERICAN SOCIETY OF TOOL
and MANUFACTURING ENGINEERS
'61

Index of Advertisers

December 1960

The Index to Advertisers is published as a reader service. Although every precaution is taken to assure correct listing, no allowance will be made for error or omission.

*Exhibitor in 1960 ASTME Tool Shows

FOSDICK JOB APPLICATION AD RATING

†1960 Suppliers Directory Issue

Most of the companies listed below have Information Listings in the 1960 Suppliers Directory Issue

A

*†Ace Drill Bushing Co. 8
*Ace Drill Corp. 126
Advance Products Corp. 202
Alkon Products Corp. 194
*†Alina Corp. 150
*†Allegheny Ludlum Steel Corp. ... 159
Allen Mfg. Co. 119
*†Allied Products Corp., Richard Brothers Punch Division 177
*Almco Division, Queen Products, Division King-Seeley Corp. ...188A
*American Chain & Cable Co., Wilson Mechanical Instrument Division 121
*†American Drill Bushing Co. 8
*†American Society of Tool & Manufacturing Engineers 188D
*American Twist Drill Co., Subsidiary Cutting Tool Division, Brown & Sharpe Mfg. Co. 120
*†Ames Co., B. C. 166
Anaconda American Brass Co. ... 29
Annual Advertising Index 213-216
Anton Machine Works 203
Armstrong-Blum Mfg. Co. 141
*†Atlas Press Co., Clausing Division 182
*Atrax Co., The 164
Automatic Mill Inc. 202
Automation Devices, Inc., Vibratory Feeder Co., Division. 184

B

†Barber-Colman Co. 178-179
Bath & Co., Inc., John 34
Bay State Abrasive Products Co. 186-187
†Bay State Tap & Die Co. 18
Behr-Manning Co. 183
*Bendix Aviation Corp., Industrial Control Section 2
†Bethlehem Steel Corp. 31
Black & Decker Corp., Master Power Corp., Subsidiary 137
*Bliss Co., E. W., Die Supply Division 125
Boggis Co., Henry P. 202
Bokum Tool Co. 203
Borg-Warner Corp., Rockford Clutch Division 132
*†Bridgeport Machines 27, 28
*Bristol Co., The 128
*†Brown & Sharpe Mfg. Co. 21-25
*Brown & Sharpe Mfg. Co., Cutting Tools Div., American Twist Drill Co., Subsidiary 120
*Brown & Sharpe Mfg. Co., Nelco Cutting Tools Division ... 123
Bruning Co., Charles 219

C

Carborundum Co. 112-113
*†Carr-Lane Mfg. Co. 219
*Cawi Machine Co., The 196
*Chicago Rivet & Machine Co. 124
Cincinnati Milling Machine Co., Heald Machine Co., Subsidiary .....Inside Front Cover
Cincinnati Milling Machine Co., Milling Machine Division 19
*Circular Tool Co. 107
*†Clausing Division, The Atlas Press Co. 182
*†Clearing Machine Corp., Division U. S. Industries, Inc. ...Back Cover
†Cleveland Twist Drill Co. 17
*†Cogsdill Tool Products, Inc. 129
Columbus Die-Tool & Machine Co. 134
Coolant Equipment Corp. 202
Cooper Weymouth, Inc. 188
*Coromant Division, Sandvik Steel, Inc. 32
Cross Co., The 10-11
*†Cushman Chuck Co. 195

D

*†Danly Machine Specialties, Inc... 191
*†Detroit Stamping Co. 110-111
Dexco Corp., Raymac Division 203
Dow Mechanical Corp. 204
*Dow Metal Products Co., Division Dow Chemical Co., The 138
Durant Tool Co. 203
Dwight Instrument Co. 204
Dykem Co., The 196

1961 DIRECTORY of SUPPLIERS ISSUE

Published March 15, 1961

Closing Date February 8, 1961

E

*Engelhard Hanovia, Inc., Industrial Diamond Division..14-15
*†Ex-Cell-O Corp. ..Inside Back Cover
Ex-Cell-O Corp., Robbins Sine Plates, Greenville, Ohio Plant.. 151

F

F & D Tool Co., Inc. 204
*†Federal Products Corp. 6-7

G

*Gaertner Scientific Corp. 126
*†Gardner-Denver Co. 16
Gatco Rotary Bushing Co. 199
*General Electric Co., Metallurgical Products Dept. 162-163
*Gisholt Machine Co. 30
Greenlee Bros. & Co. 116
*Grob, Inc. 198

H

Hardinge Brothers, Inc. 5, 163
*Hartford Special Machinery Co.. 157
Heald Machine Co., Subsidiary Cincinnati Milling Machine Co. .....Inside Front Cover
Holcroft & Co. 106
*Hughes Aircraft Co. 9
*†Hunt Valve Co. 185
Hutchinson Co., William T. 200

I

Induction Heating Corp. 133

J

*Jarvis Corp. 140
*Jones & Lamson Machine Co. 167

K

*†Kennametal Inc. 142
King-Seeley Corp., Almco, Queen Products Division 188A
Kingsbury Machine Tool Corp... 181
King Tester Corp. 134

L

Lapointe Machine Co. 171
†Lapointe Machine Tool Co. 33
†Latrobe Steel Co. 180
Lepel High Frequency Labs. 122
Lindberg Engineering Co. 174
Linderme Engineering & Sales... 203
*Lovejoy Tool Co. 127

M

Manhattan Rubber Division, Raybestos-Manhattan, Inc. 170
Marvel Tool & Machine Co. 196
*Master Power Corp., Subsidiary, Black & Decker Corp. 137
*Mayline Co., Inc. 190
*Metallurgical Products, Dept., General Electric Co. 162-163
Meyers Co., W. F. 194
Michigan Oven Co. 188
*Michigan Tool Co. 192-193
*†Moore Special Tool Co. 131
Morse Twist Drill & Machine Co., Subs., Van Norman Industries, Inc. 173

N

National Machinery Co., The 120
*Nelco Cutting Tool Division, Browne & Sharpe Mfg. Co. 123
New York Twist Drill Co., Inc. ... 154
Norgren Co., C. A. 169
Norton Co., Machine Division ..12-13

O

*†O. K. Tool Co., Inc., The 130
*Olsen Testing Machine Co., Tinius 190
*Ortman-Miller Machine Co. 146
*Osborn Mfg. Co. 20

P

*†Parker Fittings & Hose Division, Parker-Hannifin Corp. 108
Penninsular Grinding Wheel 135
†Pipe Machinery Co. 26
Pope Machinery Corp. 9
*Precision Tool & Mfg. Co. 184
*†Producto Machine Co., The 175

Q

Queen Products Division, Almco, King-Seeley Corp. 188A

R

†Raybestos-Manhattan, Inc., Manhattan Rubber Division.... 170
†Raymac Division, Dexco Corp..... 203
†Ready Tool Co..... 202
*†Richard Brothers Punch Division, Allied Products Corp..... 177
†Robbins Co., Omer E..... 151
Rockford Clutch Division, Borg-Warner Corp..... 132
Royco Tap & Tool Corp. 202
Russell, Holbrook & Henderson, Inc. 152
Ryerson & Son, Inc., Jos. T..... 36

S

*Sandvik Steel, Inc., Coromant Division..... 32
*†Seibert & Sons, Inc..... 199
*Sentry Co., The..... 196
*Service Machine Co..... 188
*Sheldon Machine Co..... 200
*Simpson Optical Mfg. Co. 115
Sinclair Refining Co. 197
Slocomb Co., J. T..... 146
Smith & Son, James..... 204
*Standard Electrical Tool Co.... 156
Standard Pressed Steel Co.....188B
*Standard Tool & Mfg. Co..... 147

T

Thompson Grinder Co..... 189
Thomson Industries, Inc.....188C
*Thor Power Tool Co..... 158
*Threadwell Tap & Die Co..... 4
†Tietzmann Tool Corp..... 194
Timken Roller Bearing Co..... 165
Tinius Olsen Testing Machine Co. 190
*†Tomkins-Johnson Co..... 114
Tool Crib Section.....202-204
Torrington Mfg. Co..... 172
Triax 201

U

U. S. Industries, Inc., Clearing Machine Corp..Back Cover
Universal Cyclops Steel Corp.... 161

V

Van Norman Industries, Inc. Morse Twist Drill & Machine Co., Subsidiary..... 173
*Vascoloy-Ramet Mfg. Corp..... 104
Verson AllSteel Press Co..... 176
*Vlier Engineering, Inc., Wespo Division..... 148

W

Warren Electr-O-Line..... 203
*Weber Gage Co..... 136
*Wespo Division, Vlier Engineering, Inc..... 148
Wheatley Economy Die Sets, Inc.. 144
*†Whistler & Sons, Inc., S. B..... 190
*Wilson Mechanical Instrument Division, American Chain & Cable Co..... 121

Y

Yoder, Co., The..... 122

Z

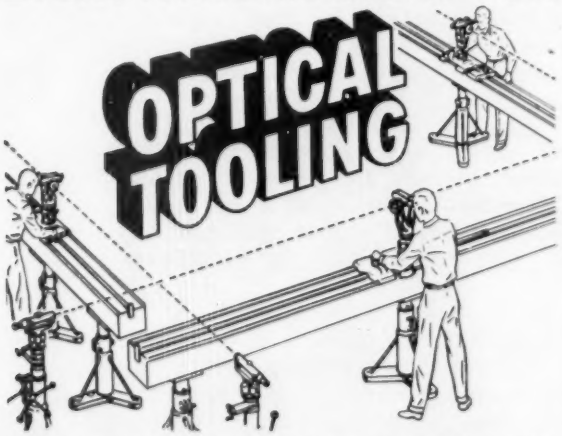
*†Zeiss, Inc., Carl..... 160

REGIONAL ADVERTISING OFFICES

Austin G. Cragg, Director of Sales, 400 Madison Avenue, New York 17, N. Y. Telephone PLaza 9-4018

NEW YORK, 17:	Austin G. Cragg; Francis Baldwin, John Clarke, 400 Madison Avenue	PLaza 9-4018
WEST HARTFORD:	Donald N. McElwain, 2636 Albany Avenue	ADams 3-5997
CLEVELAND, 14:	George J. Zavis, 1367 E. Sixth Street, Room 200, Lincoln Building	TOwer 1-0330
CHICAGO, 11:	Stanley F. Girard, 612 North Michigan Avenue	MIchigan 2-4465
DETROIT, 38:	Alan Cobleigh, 10700 Puritan Avenue, W.U.:ZNV Detroit; TWX: DE 974	UNiversity 4-7300
ATLANTA, 3:	Gus Krimsier; Cogill, Pirnie & Brown, 1722 Rhodes-Haverty Building	JAckson 2-8113
LOS ANGELES, 4:	Dillenbeck-Galavan, Inc., 266 South Alexandria Avenue	DUnkirk 5-3991

EVERYTHING IN SIGHT FOR



Look to Bruning for Brunson Optical Tooling — the most advanced and complete line of equipment on the market. Brunson Optical Tooling has proved it can slash tooling set-up time as much as 90%, provide accuracy to .001". Investigate the savings you can make by phoning your nearby Bruning Sales Branch, or mail the coupon below for a prompt reply.

BRUNING

BRUNSON

Charles Bruning Co., Inc. Dept. 12-XA
1800 Central Road, Mt. Prospect, Illinois
Offices in Principal U. S. Cities
In Canada: 103 Church St., Toronto 1, Ontario
Please send me more information on Brunson Optical Tooling.

Name_____ Title_____
Company_____
Address_____
City_____ County_____ State_____

Use Reader Service Card, CIRCLE 166

YOU'RE
BOUND TO SCORE!
No matter which one carries the BALL...

if they're CARR-LANE
COMPONENT PARTS OF JIGS and FIXTURES

Carr Lane MANUFACTURING CO.
4200 Knox Court • St. Louis 39, Mo.

Write for CATALOG Today

Use Reader Service Card, CIRCLE 167

LOOKING AHEAD

By T. W. Black
Senior Associate Editor

A new international standard of length—a wavelength of light—has replaced the platinum-iridium meter bar that has served as a standard for over 70 years. The meter is now defined as 1,650,763.73 wavelengths of the orange-red line of krypton 86. Length of an inch is now 41,929.399 wavelengths of the krypton light.

With adoption of the new standard, standards laboratories will no longer have to return duplicate meter bars to Paris for recalibration in order to keep length measurements on a uniform basis throughout the world. The new standard can be reproduced in any well-equipped laboratory.

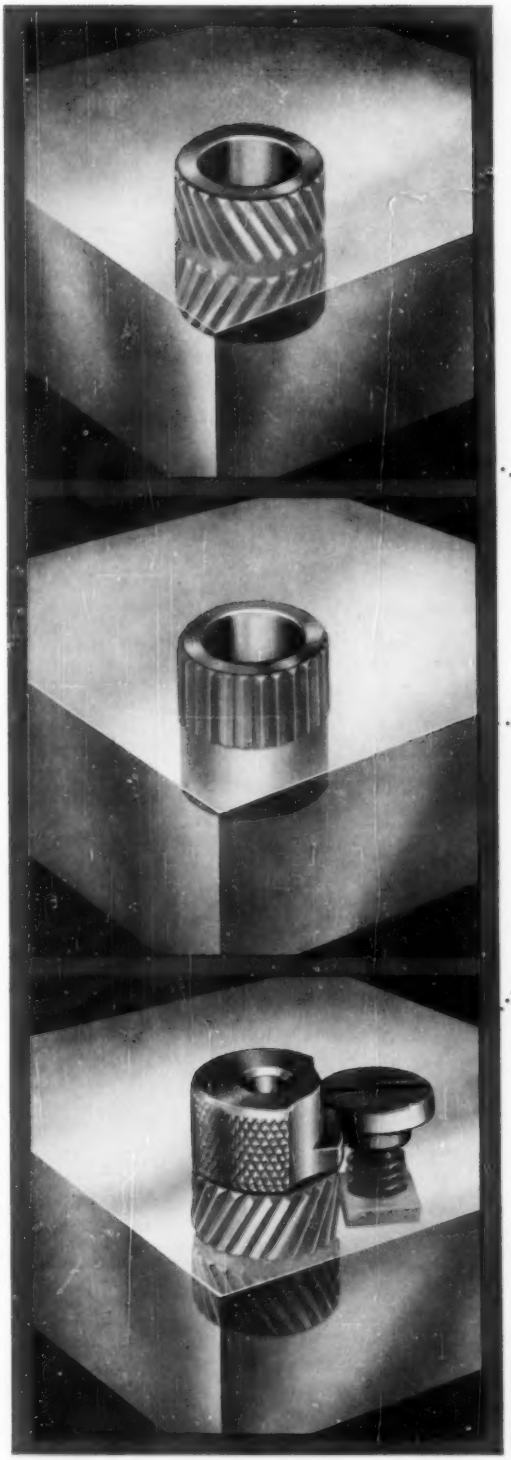
Automation has been put to work for making literature searches by the American Society for Metals Documentation Service. More than 65 companies are receiving digests of the world's metallurgical literature in the particular areas of scientific and technical information that especially concern them. A standard, general-purpose computer, programmed for literature searches, is used to find this information.

A special-purpose analog computer at the Aliquippa, Pa. works of Jones & Laughlin Steel Corp. calculates the proper proportions of hot metal, scrap and lime to be charged into a basic oxygen furnace so that any desired type of steel can be tapped at the desired temperature. The tapping temperature plays an important role in the quality of the finished product in the basic oxygen steel-making process.

From 100 to 300 percent increased tool life has been reported by European companies using a bonded lubricant coating introduced in this country by The Alpha-Molykote Corp., Stamford, Conn. Twist drills, reamers, broaches, gear cutters and bending tools coated with this material have been extensively tested, with substantial life improvements.

Thickness of the coating, called Molykote PVE, is 0.00008 to 0.0001 inch. The coefficient of friction is 0.03 at 100,000 psi, and it operates from —300 to +600 deg F. The coating, which is sprayed with an ordinary paint gun, dries to a thin, tough film in about five hours at room temperature. The lubricating agent is molybdenum disulfide.

Logan T. Johnston, Armco Steel Corp. president, has called for a revised U.S. depreciation policy to enable American manufacturers to meet foreign competition. "We simply cannot afford to modernize fast enough to keep pace with our foreign competitors and, at the same time, maintain a fair rate of return to the owners of the business," he says. "Depreciaton allowances, which do not recognize the effects of inflation, and place barriers in the path of industrial growth, are largely responsible."



NOW in STOCK for Immediate Delivery...

Ex-Cell-O Drill Jig Bushings for All Plastic Tooling Jobs!

FOR 'POTTING'...

Ex-Cell-O Trans-Lok Bushings have exclusive herringbone knurl and annular groove design for maximum security in potted-type jigs, fixtures and templets. Bushings can't twist or pull out.

FOR PRESSING...

Ex-Cell-O Press-Lok Bushings have straight knurls for greater gripping power when pressed into plastic, wood or other ductile materials.

FOR RENEWABLE BUSHINGS, TOO...

Ex-Cell-O Trans-Lok Liners, with the same deep transverse ridges as Trans-Lok Bushings, permit drilling or reaming using standard fixed-renewable or slip-renewable bushings.

Made of high chrome, high carbon oil-hardening bearing steel, Ex-Cell-O Bushings for plastics have uniform hardness, 62-64 Rockwell C precision ground diameters, and conform to A.S.A. standards and Ex-Cell-O's own high standards for quality.

Send today for catalogs covering Ex-Cell-O's complete line of bushings for plastics and metal or order direct from stocks in Detroit or Downey, Cal.

60-70

EX-CELL-O FOR PRECISION

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • CONTOUR PROJECTORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Precision Parts Division

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

Use Reader Service Card, CIRCLE 103

YOU SAVE WITH CLEARING PRESSES

With a bottom drive press, the main floor is cleared for better material handling, increased safety and improved appearance. The lower level simplifies scrap removal and equipment maintenance.

WITH A LINE LIKE THIS...OR A LINE OF TORC-PAC O.B.I.'s—CLEARING PROVIDES THE ULTIMATE IN METAL FORMING EFFICIENCY

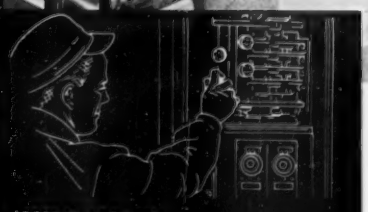
Clearing is now building a line like the one above. Presses like these equipped with moving bolsters and the latest features and control devices (as shown at right) are the way to increase profits and production by combatting rising material and manufacturing costs.

Undoubtedly, your production problem is different from the one solved by the press line above. However, whatever the problem—whatever the type or size of press equipment, feeding equipment and dies are best for you—you can rely on Clearing for the most effective solution. Call on Clearing at any time.

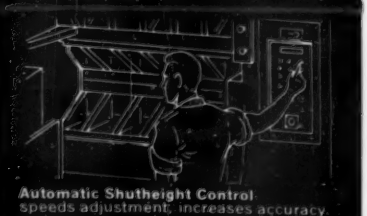
Bulletins on Moving Bolster and Bottom Drive Presses are available now.

USI Clearing

DIVISION OF U. S. INDUSTRIES, INC.
6499 W. 65th Street • Chicago 38, Illinois



360° Limit Switch speeds changeover time.



Automatic Shutheight Control speeds adjustment, increases accuracy.

Hydraulic Overload Protection increases safety.

Look for the CLEARING NAME on these products

Mechanical Presses • Hydraulic Presses • Torc-Pac O. B. I. Presses • Axelson Lathes • Harrison Lathes • Special Equipment for Aircraft & Missiles Mfg. • Dies • Torc-Pac Drives